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# Man and Animals in the New Hebrides

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Fig. 1. Typical Vegetation in the New Hebrides.
*(Photo by Mr. J. de H. Morel.)*

[*Frontispiece*

# Man and Animals in the New Hebrides

By

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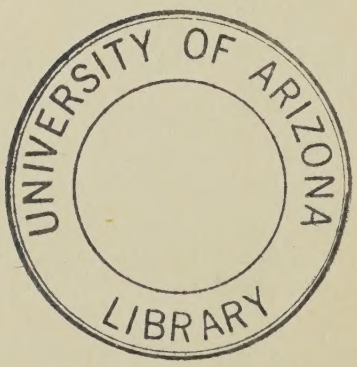
Percy Sladen Trust Expeditions
to the New Hebrides
1922–3 and 1927

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*To my many friends, both white and black,*
*in the New Hebrides,*
*especially*

| | | |
|---|---|---|
| *W. A.* | | *"Alec"* |
| *R. E. T.* | *"August"* | *Dhipla* |
| *T. O. T.* | | *"Tilly"* |

65/66

# PREFACE

IF I were to make really adequate mention of the kindness of all those who have helped me in connexion with my work in the New Hebrides, this Preface would be disproportionately long. The reader must realize that the few words which follow are tokens of very real gratitude.

My two visits to the New Hebrides were partly financed by the Trustees of the Percy Sladen Memorial Fund and by my mother and brother (Mrs. G. E. Baker and Mr. S. J. Baker). The latter has also helped very greatly by preparing the maps which illustrate this book and in many other ways. For great kindness and helpfulness while in the islands I am indebted to Mr. and Mrs. W. Anderson, the Rev. R. E. Tempest, and Mr. T. O. Thomas ; and I thank Professor T. T. Barnard for his companionship on my first visit. To my wife and Mr. J. de H. Morel, who joined me towards the end of my second visit, I am grateful for infusing the new enthusiasm which resulted in the achievement of our most important objects.

I wish also to thank the following :—

*For giving me the necessary leave of absence, and for advice :—*
Professor E. S. Goodrich, F.R.S.

*For help in the New Hebrides :—*
Mr. J. R. Salisbury (especially).
Mr. O. Stevens.
Père Ardouin.

The Rev. and Mrs. F. G. Bowie.
The late H.B.M. Resident Commissioner.
Mr. Bell.
The Captain of S.Y. *Southern Cross*.
Captain Brown.
Messrs. Burns, Philp & Co.

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Mr. H. W. Parker (Reptiles).
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„ „ *The Journal of Ecology.*

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„ „ *Man* (Fig. 7).

„ „ *Nature* (Fig. 43).

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*For redrawing three of the maps for publication (Figs. 12, 26, and 38), and for allowing me to reproduce these and several photographs which will appear in the "Geographical Journal" :—*

The Royal Geographical Society.

JOHN R. BAKER.

Department of Zoology and Comparative Anatomy,
Oxford.

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# MAN AND ANIMALS IN THE NEW HEBRIDES

## Chapter I

## INTRODUCTION

I WAS demonstrating to a zoological class at Oxford one day, when Professor (then Mr.) J. S. Huxley suddenly asked me whether I would care to go to the New Hebrides to accompany an anthropologist from Cambridge who intended to work there. I was quite ignorant of this group of islands, and indeed hardly knew where to look for it on a map ; but the idea of biological research among a primitive people in the South Seas was too great an attraction to allow mere ignorance of its geographical position to deter me from at once deciding to go. The Trustees of the Percy Sladen Memorial Fund partly financed me, and in a few months Mr. T. T. Barnard and I were on our way to this little-known quarter of the globe.

That was in 1922. After five months in the islands I came back to Oxford to resume my duties. It is said of many places that if one has once visited them, an irresistible impulse draws one back despite all the discomforts one may have experienced there ; and this certainly applies with great force to the New

Hebrides. I had not been long in England when I started making preparations for another visit. Professor E. S. Goodrich most kindly gave me a year's leave of absence from the Department of Zoology and Comparative Anatomy at Oxford, and in 1927 I was back there again to spend a further period of seven months among the very good friends, both white and black, that I had made five years before. This time my visit was on a much more elaborate scale, for thanks to the generosity of the Percy Sladen Trustees and of my mother and brother I was splendidly equipped with everything that my previous experience had shown to be necessary. A heavy tent, a light tent, a featherweight tent, waterproof knapsacks for carriers, a mountain of tinned food, special boxes to hold jars in which to preserve specimens, dissecting, surveying, and meteorological instruments, guns, dynamite, a collapsible boat, everything, in short, that I was likely to require for my researches was at hand.

With these impedimenta I sailed from Sydney. Excellent as was my material equipment, my personnel was the reverse. I had arranged for my brother to accompany me as surveyor and a zoology student as assistant in the biological work ; but the latter had been prevented from coming a short time before we sailed from England, and my brother turned back at Colombo owing to illness. Arrived in Australia I chose a total stranger to accompany me as surveyor;

140
150
160
170
180
0
10
20
NEW GUINEA
SOLOMON
IS.
TORRES IS.
BANKS IS
Vanua Lava
Gaua
Espiritu Santo
NEW
HEBRIDES
Malekula
Ambrim
Efate
FIJI IS.
NEW
CALEDONIA

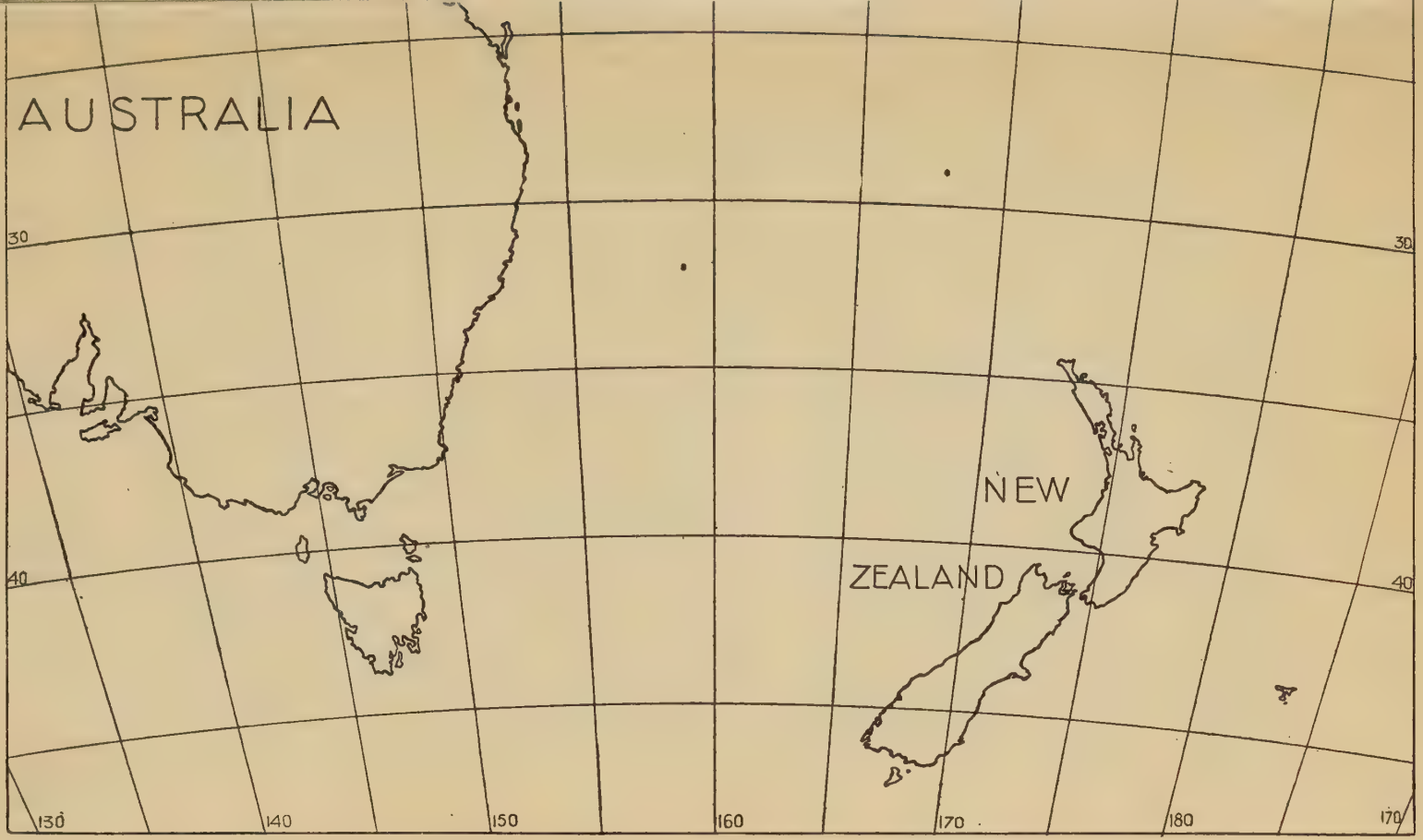



Fig. 2. Map of the Western Pacific Ocean. Scale 1 : 15,000,000. Drawn on Bonne's projection by Mr. S. J. Baker.

[*To face p.* 2

but he left me before much had been accomplished. Later my wife and Mr. J. de H. Morel joined me, and from that time onwards everything went well with the expedition.

It was a pouring wet morning, when, after the fortnight's sail from Sydney, my baggage and I were dumped on the white coral sand at Hog Harbour in the island of Espiritu Santo. I had hoped for a couple of hours' sunshine in which to erect our base camp ; but in the New Hebrides Jupiter Pluvius reigns supreme, and everything not in tins was soaked through. I must now introduce the reader to the temporary home, at which I made such an unpropitious arrival.

The New Hebrides are an archipelago of mountainous islands in the western Pacific Ocean, consisting mostly of volcanic and coral rock with some sedimentary strata extending back to the Miocene (Fig. 2). Earthquakes are common. The climate is tropical, with heavy rainfall, and all the islands except the most southerly ones are clothed over nearly the whole of their surface from high water mark to the tops of the mountains with luxuriant forest vegetation (Frontispiece). They are inhabited by Melanesians, a primitive, very dark brown race with large lips, broad nose and curly black hair. The fauna is a typical one for a group of islands which has never been near a continent. The only indigenous land Mammals are five species of fruit-bat, two

insectivorous bats and one species of rat. There are also wild pigs, derived from the domestic Sus papuensis, which was probably brought to the islands by the natives when the islands were first colonized by them.

So long ago as 1606 the most northerly islands of the New Hebrides were discovered by the Spaniard Quiros. More than a century and a half elapsed before another European visited the group. This time the explorer was a Frenchman, Bougainville, who discovered several islands to the south of those found by Quiros. The islands lying still further south were discovered by Captain Cook in 1774. Cook gave the name "New Hebrides" to all the islands lying south of the two northerly groups of small islands called the Torres Islands and the Banks Islands. The name is still often used to exclude these two groups ; but since they are one with the main group of islands geologically, ethnologically, zoologically, botanically, politically and economically, and since further the Torres Islands are not separated from the Banks, nor the Banks from the main group by a greater distance than separates certain of the islands of the main group from one another, it seems to me far best to have one name to include all the islands ; and the significance of the name "New Hebrides" should be extended to cover them all. Throughout this book I use the name "New Hebrides" with this extended significance.

The political position of the New Hebrides is the outcome—and an unfortunate one—of the " Entente Cordiale " between Great Britain and France. The islands belong equally to the two countries and thus constitute a Condominium. The British in the group are subject to British law and the French to French law. This results in considerable friction, for the French are allowed to indenture labour from abroad while the British are not (1927); and the regulations forbidding sale of alcohol to natives are not strictly enforced by the French, so that the French planters also have an advantage in recruiting New Hebridean labour. There is a British and a French Resident Commissioner and a British and a French Judge. The whole administration is in duplicate. The law court scarcely ever sits owing to the difficulty of getting all its constituent members in the New Hebrides at the same time, since some are nearly always on vacation. At the time of my last visit, I believe that not a single person in the group had a proper title to his land. The consolidation of the friendship of the two countries by the formation of this Condominium, though admirable in its conception, has resulted in an administration which could be readily adapted to comic opera but is really rather far removed from the sphere of practical politics. If the New Hebrides were of very great economic importance, probably some agreement would be come to whereby the islands were ceded to one nation or partitioned

among the two ; but as they are not, neither nation cares to disturb its friendship with the other by bringing this matter forward.

Just before I left the group I witnessed an ugly incident which shook any faith I might have had in the form of government. As the boat that was carrying me steamed into Vila harbour, I saw a ship's lighter filled almost to overflowing with Tongkinese or Annamese indentured labour. There must have been a hundred persons on the little boat, nearly all standing simply because there was not room to sit. Since nothing seemed to be happening to the boat-load, I made enquiries as to why these people should be left standing crowded together under a tropical sun. I was told something that would have shocked a less tender conscience than mine. The people had arrived at Vila several days before. Since some of them had mumps, they were not allowed to land ; all of them, with and without mumps, were put into the lighter and left there, food being brought to them from time to time. To have put them there for an hour would have been culpable. A little tent had been erected in the middle of the lighter, but that was scarcely helpful when the boat was crowded from stem to stern. Those who have been in an open boat lying stationary under a tropical sun can form some concept of their plight during the daytime. What they did at night I do not know : certainly few of them can have lain down owing to the lack of space. I went at

once to the British Resident Commissioner. He explained that since the people concerned had been indentured by Frenchmen, the matter was entirely in the hands of the French Resident Commissioner, and that protests from Britons would be disregarded. It is not easy for the two countries to work hand in hand when their methods in matters of this sort are so different.

The soil of the New Hebrides is very fertile, and many tropical plants of economic importance flourish. Copra, the dried kernel of the coconut, is the chief export. Many planters cultivate cocoa and cotton as well. The banana grows splendidly, and would be extensively cultivated if there were not a high tariff preventing its import to Australia.

There are rather over a thousand whites scattered round the coasts of the islands. The seat of Government is at Vila, on Efate Island, where there is a little town with a post-office and a hotel. The only other place where many whites are gathered together is on the shores of the Segond Channel, which separates the largest island, Espiritu Santo, from the small island of Auri.[1] Nearly all the white inhabitants are planters, traders or missionaries, with their families. The two chief missions, the Presbyterian and the Church of England, have wisely partitioned the

[1] The accepted spelling of the name of this island is "Aore". I have preferred to spell it in accordance with the R.G.S. II system. For the same reason I spell "Ambrim" with an "i" instead of the accepted "y", and change the accepted "Aoba" to "Omba".

islands among them so as not to interfere with one another's work. There is an amusing divergence of opinion between the missions on the subject of the use of stimulants. Thus while the Seventh Day Adventists do not allow their followers to drink tea or coffee, far less alcohol, a Roman Catholic missionary once told me jovially how a fellow priest had instructed him in the art of making artificial absinth by mixing a paregoric medicine with rum !

It seems questionable whether all the religious teaching is beneficial. It is difficult for instance to see precisely what moral lessons these primitive people are supposed to draw from the greater part of the Old Testament. Once I went to a mission service which was being conducted by a native who was supposed to have learnt English. There being no person present other than myself with any knowledge of English, I was somewhat surprised to hear him begin the lesson in a stumbling attempt at my own tongue : but my astonishment was far greater when I found that the story he had chosen for my benefit was that of Rahab the harlot !

It is very far from being my intention in this book to give an exhaustive account of the New Hebrides. My main object, after this introductory chapter, is to present the results of my own researches. I hope that no one will take up the book thinking that it will contain the easily-read rambling jottings of a naturalist of the old sort. My investiga-

tions were those of a naturalist in the sense of one who is interested in the world and its inhabitants, human and otherwise, in a scientific spirit ; and I do not try to simplify what I have to say beyond leaving out scientific terms whose meaning is not well known. I hope in this way to make the book readable by scientist and layman alike. A full index is provided to render it useful to those who have only circumscribed interests in the New Hebrides. Parts whose interest is likely to be restricted to relatively few readers is printed in small type so that it can conveniently be skipped.

I must advise the reader to acquaint himself with the geography of the island of Espiritu Santo before reading further, since most of my work was done there. (Fig 3.) To describe the island very roughly, it is square in shape, with a north-eastern and a north-western peninsula enclosing a bight called Big Bay between them. The eastern half of the island is largely a plateau of upraised coral at an elevation of 300–600 feet above sea-level. The only considerable elevation in the eastern half is at Mt. Turi (1,760 feet by my aneroid). The western half is very mountainous, rising in Mt. Tabwemasana to the height of 6,169 feet. The largest river is the Yoro or Jordan, which flows north into Big Bay. Many rivers, some of them of considerable size, flow out to the south. The reader should particularly notice Hog Harbour, on the east coast, and the district called Sakau in which it is situated.

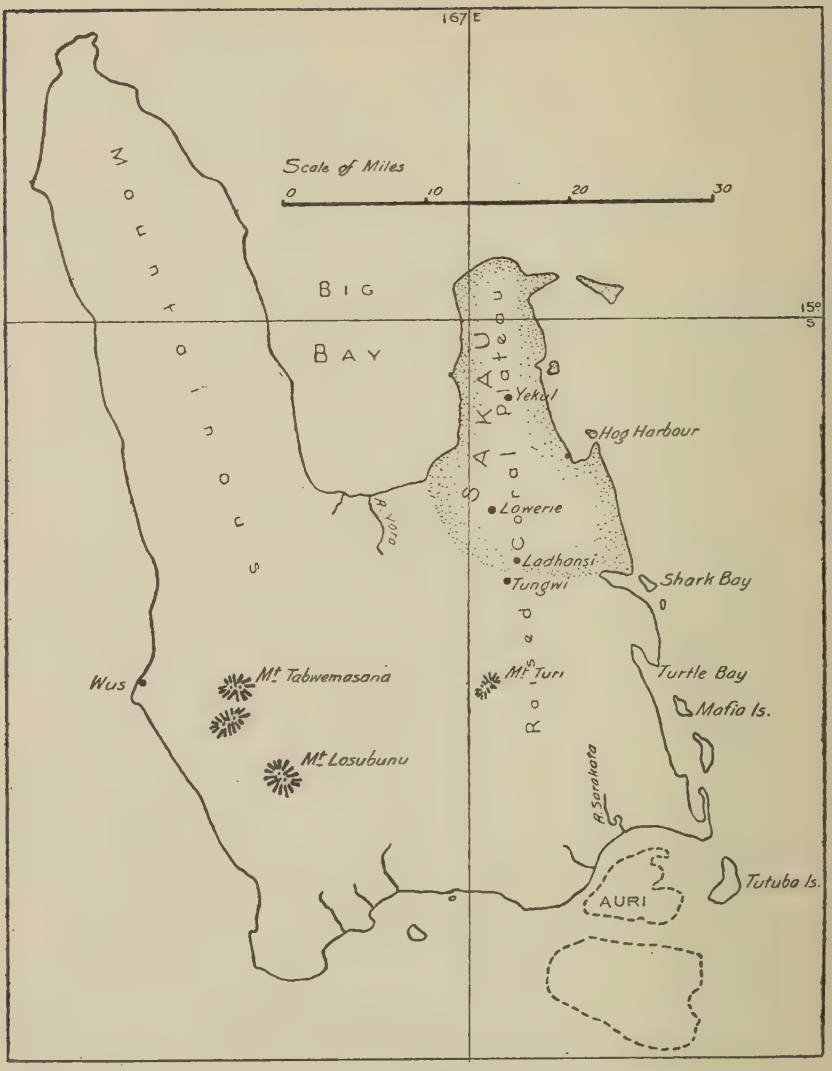



FIG. 3. MAP OF ESPIRITU SANTO.

The Coast-line is from the map of the French Ministère des Colonies.

(See footnote on p. 7.)

Fig. 4. Men of Sakau.
*(Photo by the Author.)*

Fig. 5. Women of Sakau.
*(Photo by Mr. J. de H. Morel.)*
*By kind permission of the Royal Anthropological Institute.*

[*To face p.* 11.

## Chapter II

# THE NEW HEBRIDEANS[1]

I DOUBT whether the reader would consider the natives of Sakau as handsome, or indeed as anything else than unmistakably ugly, by our standards ; but any facial defects are atoned for by the perfection, in many cases, of the physique of the rest of their bodies. Luckily they do not hide their light beneath a bushel. (Figs. 4 and 5.) This is particularly so in the case of the women, for at first sight they appear absolutely naked. A fine thread passes round the hips, and to this is attached in front a strip of some monocotyledonous leaf, about ½ in. to 1 in. wide and 6 in. long, which passes between the legs and to some extent hides the external genitalia, though the *mons veneris* is only partly covered. It is held in position by the insides of the legs and does not protrude behind. A bunch of leaves hangs from the thread behind. The men are more elaborate in their attire. A leather belt passes round the hips, from which depends in front a strip of calico about a foot long by six inches wide, and behind a bunch of leaves (often crotons). This costume has replaced the old in the last quarter of a century, owing to the arrival of whites who

[1] This chapter refers to the heathen of Sakau except where the contrary is stated, but much of it is of more general application.

exchange calico for native produce and labour. Formerly the men wore a most remarkable spindle-shaped block of Casuarina wood over their buttocks, held in place by numerous beaded strings, with a strip of native-woven cloth in front. (Fig. 6.)

To ornament themselves, they smear their faces with pigments or stick the flowers of Hibiscus and other plants in their hair. An anthropologist whose theories demanded a light-haired ancestor for these people was delighted to find some of them veritable blondes. It is unfortunate that no one told him that lime applied to the scalp, and not a far-off progenitor, was the cause of this apparent confirmation of his speculations ! The traders sell them beads, and it is a most remarkable fact that only one special sort of bead will suit the people of Sakau. Be it slightly too large or translucent, it cannot be sold. It is wonderful that they should be so conservative in their tastes as regards an article of European origin.

The heathen natives, both male and female, hold themselves very erect, and the men generally stride lightly along with an appearance of vigour and self-confidence which it is a delight to behold. The same cannot be said of most of the Christianized ones.

Those who have lived for many years among the New Hebrideans profess that a year's acquaintance with them gives little insight to the mental character of the race, and that one continually comes across unexpected traits which upset one's previous estimates.

Fig. 6. Men of Sakau in the old costume.
*(Photos by the Author.)*
*By kind permission of the Royal Anthropological Institute.*

Back view.

[*To face p.* 12.

But certain points stand out clearly. They are on the whole a cheerful people, often laughing, and laughing at much the same things as we do. As regards honesty, the less civilized and the uncivilized ones never steal, in my experience ; though those who work on plantations sometimes develop this habit. I used to leave all my tinned meats and stick-tobacco lying about in my tent, and yet never lost a single tin or stick, though I was away from the tent during a large part of most days and often for many days together. This is a very remarkable fact, considering how much the natives appreciate these commodities and that no legal system exists to inflict punishment had they helped themselves to what they wanted. There is no doubt that they are far less prone to steal than we are in England ; otherwise we should not bother to lock our houses when we leave them empty. In the matter of truth, they are not so superior to us ; on the whole they are rather apt at inventing lies and excuses. They nearly always fall to a leading question, and no anthropologist who does not fully appreciate this fact will be able to extract truthful information from them. They are far from being dependable : one may make elaborate arrangements for a certain thing to be done on a certain day, to which they will readily agree ; but when the day comes, they often fail one. They are very child-like in their great, though short-lived, enthusiasms. We taught some Gaua natives a rude form of cricket, which they played nearly all day long

for a few days. Then, quite suddenly, they tired of it, and never played again.

In receiving gifts or payment, their etiquette forbids any sign of gratitude or pleasure, and they pretend to take no notice as one hands the article to them : often they hold it behind their backs as though ashamed. Their own name they will never mention, so that it is impossible to find out a native's name if he is alone ; if two are together, each must be asked the name of the other.

The signs for " yes " and " no " are very different from ours. The affirmative is expressed by raising the face a short distance rather quickly and allowing it to fall more slowly, or by raising the eyebrows, or by both actions together. The negative is expressed by contracting the muscles of the face, never to my knowledge by a horizontal turning movement of the head. The face is ludicrously contorted when a forcible " no " is given. In answer to a negative question their " yes " and " no " have the opposite meaning to ours. Thus if one says to a man the equivalent of " You are not married, are you ? " and he gives the sign for " Yes ", he means that he is a bachelor.

The languages of the New Hebrides are almost innumerable. The little island of Gaua, only about twelve miles in diameter, has two perfectly distinct languages, and if a native of one side of the island wants to speak to a native of the other, he must find someone

who has learnt the other language. The Melanesian (Church of England) Mission has chosen the language of the island of Mota as the medium of instruction in its schools, and the natives of other islands have to learn this before they can start on any other subject. One of the things which strikes the European learner of this language most forcibly is the freedom with which many words may be used as any part of speech. Some words can be used as noun, adjective, verb, adverb or even exclamation ! The next most impressive thing is the existence of a " dual " and " trial " in addition to a singular and plural in the personal pronouns ; and since this is combined with an " inclusive " and an " exclusive " in the first person plural, there are no fewer than six possible senses of the English word " we ". These are as follows :—

*Dual*

(1) Thou and I.
(2) He and I.

*Trial*

(3) You two and I.
(4) They two and I.

*Plural*

(5) You (many) and I.
(6) They (many) and I.

Further, to add to the complication, there are from two to four possible words for " we " in *each* of these six groups—16 words in all ! I have been told that

it is almost impossible to explain to a Mota native how we use the single word "we" to denote so many entirely different things.

It is a lucky circumstance for the traveller that there is a veritable Esperanto of the New Hebrides—pidgin-English. This language bears little relation to Chinese pidgin-English. It is spoken on plantations throughout the group, and natives who have worked on plantations can thus communicate with one another even though they come from different islands. Further, English and French people who do not know one another's tongue speak it together. Some of the words are, to put it mildly, forcible English expletives, and it is thus amusing to hear French women using them, utterly innocent of their meaning. Even in the heathen parts of the islands one may sometimes come across a man who has at one time worked on a plantation, and thus be able to converse with him.

The natives are said to learn pidgin-English remarkably quickly. The vocabulary is based on English words with the exceptions of *kai-kai* (= eat, from Polynesian), *savvy* (= know, understand, from French *savoir*), and *bouchon* (= cork, from French). The number of words is very small, and thus in order to present a difficult concept one has to talk very much round the point. I could never tire of hearing a native who has a good command of this amusing language. There are two standard illustrations of it. One is the description of a saw as "brother

belong akus [axe] ; pull 'im 'e come, push 'im 'e go ". The other is the following graphic verbal representation of a piano :—" One big fella bokus [box], 'e got tooth ; time master 'e fight 'im, 'e sing out." When my wife first joined me at Hog Harbour, the natives were heard saying of her, " Face belong 'im 'e *good* fellow too much." Of my wife and myself conjointly they said, " Two fella here 'e steraight " ( = straight, i.e. a good pair).

Into the classificatory system of relationship-notation, and the system of exogamy on which it is based, I will not enter. The reader who is interested in this curious subject will find it well set out in Codrington's *The Melanesians*[1] or Rivers's *The History of Melanesian Society*.[2] Suffice it to say that they take much more interest in relationship than we do, and calculate it in a way that is very complicated and to us very peculiar.

Polygamy occurs, as in most primitive (and many civilized) peoples ; but owing to the shortage of women, there are few men who have more than one wife. In my census of Espiritu Santo I found that in the heathen villages of Sakau there are 110 married women to 100 married men, and in the rest of the island the ratio is 114 : 100. Dhingaru, an important chief in Sakau, had five wives at the time of my visit. The prostitution of wives is common.

[1] Oxford, Clarendon Press, 1891.
[2] Cambridge, University Press, 1914.

An unpleasant custom is the hanging of the widows of chiefs. A case occurred in Sakau shortly after I had left the islands. A chief died and both his wives committed suicide in this way. It appears that the widow rushes about till absolutely exhausted and then either hangs herself or allows others to hang her.

The women are in a very subordinate position, but nevertheless sometimes possess pigs of their own. They do all the carrying of food from the gardens to the villages. One very seldom sees a man speak to a woman in the heathen villages. When there are many people together, the men and boys form one group and the women and girls another. This segregation of the sexes immediately forces itself upon one's attention.

One of the less pleasant customs of the people, though not in my view such an appalling one as many people think it, is that of cannibalism. To kill a person in order to eat him is certainly shocking ; but to eat him after someone else has killed him for some other reason is surely less criminal. Between my two visits a white man was killed in the S.W. of Espiritu Santo and the flesh of his legs divided among several villages and eaten. I have heard of no recent case in Sakau, but a native of this part, who had himself partaken of human flesh, gave Mr. Barnard and me some interesting information as to its indigestibility and the necessity of eating certain leaves with it to prevent illness.

It is perhaps surprising to find that the natives exhibit the same secrecy in defecation and excretion as we do. Although living so much among the people, I only once saw an adult native perform either of these functions. The man concerned was one who had spent several years at a Mission school for training native teachers. Probably there is less delicacy on plantations, where native culture is necessarily at a low ebb.

Nearly always there are vendettas in Sakau, where the powerful chief Dhingaru has for decades been the enemy of Nëtau in the north and Tëvor in the south, the intervening villages supporting sometimes one and sometimes the other side. But no pitched battles take place. When a man is killed on one side, a man must be killed on the other to avenge him, for otherwise the dead man remains permanently in purgatory ; and so it goes on.

About 1908 the chiefs of Sakau were so tired of the constant deaths in vendettas that some of them asked the Government to arrange a conference to see whether anything could be done. All the important chiefs agreed to come to the conference except Dhingaru. Mr. Thomas, who had a plantation at Hog Harbour, went inland and interviewed him, finding his house hidden away some distance from the main village. Dhingaru refused to come to the conference, but said that he had dreamt that there would be peace for three years, after which fighting would break out again.

Three years later, almost to the day, the long peace was ended by the discovery of two natives shot dead near Hog Harbour. A few weeks later it was found that the murderers, who made good their escape, had been paid in pigs by Dhingaru to do the deed. Great excitement now prevailed, and all the villages set sentries to guard the approaches day and night. Despite all precautions Dhingaru's supporters had soon accounted for twenty, while his opponents had only killed one. The Government put the price of £30 on Dhingaru's head, and a punitive expedition against him was organized, in which Mr. Thomas took part. The net result was a victory for Dhingaru, two bullets in Mr. Thomas, and the retreat of the punitive expedition. Despite the price on his head, Dhingaru was not killed till just after my visit in 1927.

Of the supernatural beliefs of the people I do not propose to write, for I have not much personal experience of them. I will only say that, incredible as they are, they are hardly more so than those of certain of the Missions which seek to elevate them.

Their credulity is shown by the following incident, which illustrates belief in magic rather amusingly. The native concerned belonged to a Mission village and spoke pidgin-English fluently.

I was sitting in the verandah of my tent one evening, playing my flute, when a native came up and stood very still in the pouring rain. I continued playing, greatly flattered that he should think it worth while to stand

in the rain to listen. I played for quite a long time, and then heard him clearing his throat—the invariable native way of attracting attention.

"What you want?" I asked.

"Me want 'im small, small something."

"Belong what?"

"Small, small something dynamite."

"Belong catch 'im fish?"

"No master. Me want 'im small, small, no more" (indicating a minute amount with his finger and thumb).

"Belong what?"

"Belong dog 'e no sing out." (Because my dog doesn't bark).

"Me no savvy." (I don't understand).

"One small fella dog belong me, suppose man 'e come, 'e no sing out."

"By and by you kill him finish?" (You propose to kill him?)

"No, master."

"What name you want 'im dynamite?" (Why do you want dynamite?)

"Belong dog 'e kai-kai." (For the dog to eat).

"Dog 'e kai-kai? What name?" (What do you mean?)

"Yes, master. I put 'im dynamite along meat. Dog 'e kai-kai. By and by suppose man 'e come, 'e sing out."

I was so much amused at his correlating the noise

made by exploding dynamite with the barking of a dog, that I gave him a minute speck of it, and he went away thoroughly satisfied. A few days later I asked him whether the dynamite had had a good effect. " Now dog 'e sing out little bit." A few days later again the magic had worked. " Dog 'e sing out good."

Chieftainship is not hereditary. There are innumerable systems of chief-making, each island or part of an island differing from the next. I will describe here that which holds in the Sakau district of Espiritu Santo. There are five main ranks in Sakau society ; these are, in ascending order : *nëvok*,[1] *vonërē*, *vüriar*, *vüriaru* (or *levüs*), and *vüster*. Many men never attain even the lowest rank. In order to attain the lowest, or to rise to a higher, a man must kill a certain number of male pigs and a certain number of hermaphrodite pigs or *ndrē* (with which monstrosities I deal at length in Chapter V). (See Fig. 16.) Usually a man has not enough pigs of his own, and has to borrow from others. If he is unpopular, other men will not lend him pigs, and thus as a rule only fairly popular men can rise in rank. It is a remarkable fact that no man ever sets out to keep many sows and breed pigs on a large scale, making special gardens in which to grow food for them.

[1] Throughout this book I use the Italian vowel sounds in spelling native words. In addition I use *ë* to represent the indefinite sound of the *e* in the French *le*. I use the English consonants, except that I put *dh* for the sound of the *th* in " this " (as opposed to its sound in " thin ").

I pointed out to the natives that this is what a white man would do, if he wished to rise in rank in their society. This was received with laughter, as an obvious absurdity. It is remarkable that their minds are so differently constituted from ours, that this should seem to them absurd ; yet I had precisely the same experience when I made the same suggestion on another island. Ludicrous though it seems to us, most female pigs are killed directly they are born.

A man seems to get his wealth in pigs from four main sources :—

(1) His father, if wealthy in pigs, may give him some.

(2) When his daughter marries, the bridegroom pays him in pigs.

(3) He extorts pigs from others by pretending to possess magical powers.

(4) Occasionally he allows a female pig to come to maturity and breed.

The third method is very important. A man of strong character is much feared by the other natives, who imagine that if he can obtain any of the remnants of their food, he can weave a spell over them and thus injure their health or even cause them to die. A missionary told me that death may actually be caused in this way by suggestion. The victim is told that if he pays a pig, he will not be visited with ill-health or death ; and he readily parts with one. A man called Rewar, at Port Olry, has a very great power of this

sort over the people of his village, and is rich in pigs as a result. Even the Christians in the village are scrupulously careful not to leave banana-skins, etc., lying about, lest Rewar should find them. All such dangerous relics are hidden, thrown into the sea, or fed to pigs.

It is, then, the possession of this faculty of instilling fear, combined with some degree of popularity, that is necessary for rise in rank in Sakau society.

At each change of rank a new men's house (nëviul) must be built. This may only be entered by men and boys ; women are rigorously excluded. In the Banks Islands the " gamal ", as it is there called, is subdivided according to rank, and no one may enter the part apportioned to a rank higher than his own ; but in Sakau there is no subdivision.

At each change of rank except the first a night-long dance takes place, at which there is said to be considerable sexual licence. In company with my wife and Mr. J. de H. Morel I have witnessed one of these dances at Yekul, in Sakau, on the occasion of the rise of a *vonëre*, one Tëkara, to the rank of *vüriar*.

A three hours' walk from the mission village of Hog Harbour brought us to Yekul soon after sundown. The latter part of our journey was along a specially prepared path, differing from the ordinary native track in being two or three yards wide instead of only just wide enough to admit one person. As we

approached we heard wild shrieks and two oft-repeated notes on pan-pipes. In the darkness we could just perceive a native hiding in the forest beside the path. This was evidently a sentry to warn the dancers of the approach of any unwanted stranger. He stood stock still until we had passed, and then we heard him crashing through to get to Yekul before us.

On arrival we kept very much in the background, lest the presence of white people should be resented. The path led us up to one side of an oval enclosure perhaps seventy yards long, in which the ceremony was taking place. (Fig. 7.) We sat down just within the fence of closely placed 3 ft. posts which bordered the dancing ground, and watched the spectacle by the fitful light of a great bonfire which burnt in the middle.

The ground within the fence was absolutely bare, having been cleared for the purpose of the ceremony. A house (presumably the nëviul) had been built beyond the fire, and on each side of the house were five huge baskets filled with yams and coconuts for the dancers. Each basket had been made by fixing some half-dozen 20 ft. saplings upright in the ground so as to form a cylindrical framework about 2 ft. in diameter, and binding these round to a height of eight or nine feet with rope-like lianas. Each sapling was stripped of branches and leaves except just at the top, where a little bunch of leaves was left, giving the whole structure a most grotesque appearance.

No one could have witnessed what was going on in

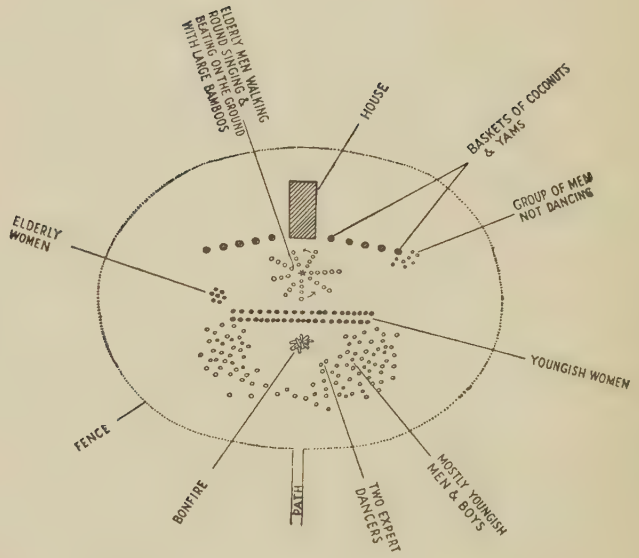
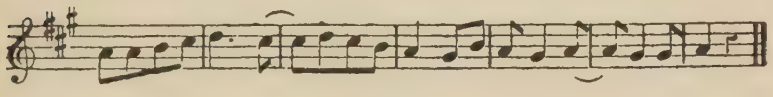



FIG. 7. DIAGRAM OF THE DANCE AT YEKUL.
*By kind permission of the Royal Anthropological Institute.*

the arena which I have described without a thrill of intense excitement passing down his spine. A couple of hundred savages, each with white fowl-feathers in his hair, his face hideous with bright pigments, a great club or a musket in his hand, and a twisted garter just below each knee, were throwing themselves into the dance with such abandon as only savages can command.

The older men had arranged themselves in lines radiating from a bundle of bamboos on which yams were hung. Round this they revolved, chanting what is said to be a saga of their history, and beating time upon the ground with thick eight-foot bamboos. There were several melodies, all seeming to have something in common. The following, though not an exact reproduction of any, gives an idea of the music :—



The young men half-surrounded the bonfire, facing it, and danced about, alternately raising their knees high in the air and then stamping their soles flat on the ground. Occasionally they uttered loud shouts in syncopated time with the singing of the older men, but they did not sing themselves. All the time they were gradually approaching the bonfire. When they had nearly reached it they would suddenly rush

back, screaming as though afraid. Their gradual approach would then begin again.

The women were in two long rows, with linked arms, and swayed voluptuously up and down all night long, singing with shrill voices.

Shortly after the beginning of the ceremony, Tëkara strode proudly round and round the arena outside the dancers, with all his near relatives—male and female, adult and young—following in his wake. Last of all was his mother, holding a coconut before her to represent the great *vüriar* as a baby. Before our arrival he had killed the ten pigs required for this ascent in rank.

Little knots of natives soon began to separate from among the dancers and approach us. They stared at us as visitors to zoological gardens often stare at curious animals—mute, disparaging, inquisitive. We all had the impression that our presence on the scene was far from being appreciated. A body of women (naked, as always) next approached and surrounded my wife. I was not a little apprehensive when they put their arms round her and began to draw her away. For a little I lost sight of her in the flickering light of the bonfire, and then I saw that the women had incorporated her in one of their two lines, and were teaching her the dance. Afterwards she told me that they had signed to her to remove her clothes, but to this request she preferred not to accede. A little later I was surrounded by some of the men and drawn into

the dance. That which had appeared easy to the spectator was soon found to be difficult to the unpractised participator ; but however unskilfully I might dance, I had sufficient of the herd-instinct to share with my savage compánions the wild joy of their ceremony. I was sorry though tired when the time came to say "Tavwa" and start our weary journey back to Hog Harbour.

The *ndrē* is not eaten at these ceremonies ; like the female it is never eaten in Sakau except by women and children (and possibly by men who have never become *nëvok*). Since the *ndrē* cannot reproduce and is scarcely ever killed except at a pig-killing ceremony, it is evident that it has no real value at all : the fact that it is worth more than the male is due to its being less abundant, yet required in these ceremonies.

The leaves of crotons are required during part of the ceremony to cover the bodies of the pigs that have been killed. At Lowerie I saw the croton-garden belonging to Yaro, the *vüriar* (?) there. It was about thirty yards in diameter and beautifully weeded and fenced. Yaro's house (presumably the nëviul which he built at his last rank-change) is the largest I have seen in the New Hebrides, being about 90 feet long by 18 wide by 8 or 9 high. Within it I counted no fewer than 101 lower jaws of well-grown male pigs, which had been killed in his rank-changes. He told me that he had thrown away those of the *ndrē* that he had killed.

As many as twenty pigs are paid for a wife. In one case of which I heard, the largest pig of the twenty was a large-tusked *ndrē* worth about £24 in our currency.

Pigs are the standard currency of the people of Sakau. As was mentioned before, they lend them to one another ; and thus they become indebted to one another in a most complicated way. If a small pig is lent, a pig of the size which it would have attained must be returned later on. The value of a male or *ndrē* depends very largely on the tusks. (Fig. 25.) The more nearly they approach a complete circle, the more valuable is the pig, even if the pig itself is a small one. If one of the tusks is broken, the pig is almost worthless. After the death of the pig, however, the tusks have little value.

It is not too much to say that pigs, especially intersex pigs, are the chief interest of the people of Sakau. Mr. T. O. Thomas has even seen a woman suckling one at her breast. They have elaborated a remarkable nomenclature of the various sorts of intersex pig, according the anatomy of the external genitalia. This will be explained in Chapter V.

The people of Mafia, a small island off the east coast of Espiritu Santo, specialize in trading in pigs. One day they brought four large intersex pigs with complete or almost complete tusks to Hog Harbour. In exchange the people of Sakau gave them 100 very small intersexes and 20 large ones with small

tusks. (I myself counted these pigs.) The Mafia men took these intersexes in their boat to the islet of Tutuba (to the S.E. of Espiritu Santo), where they were required for a rank-change ceremony, receiving about eight complete-tusked intersexes in exchange from the Tutuba people. They thus made a profit of four complete-tusked intersexes.

In S.E. Espiritu Santo I came across a curious case of the pig being used as a means of reconciliation between enemies. There had been some fighting among the people, and a young chief had installed himself on Mt. Turi and was terrorizing the people of the surrounding villages. Mr. W. Anderson, the Presbyterian missionary of eastern Espiritu Santo, decided to go to Mt. Turi to try to put an end to the trouble, and Mr. (now Professor) T. T. Barnard and I accompanied him. We went inland and spent some days visiting the oppressed villages. From each we took one or two of the chief men, sending a message to the oppressor that we should bring them all to a conference at his village on the mountain. There was no disorder when we arrived with our long file of the oppressed in the enemy's village on the mountain. We insisted on all the muskets being placed together in our shelter, lest heated argument should incite recourse to arms. The chiefs all sat down on their haunches and the conference began. One after another spoke, but no settlement seemed possible. By means of an interpreter Mr. Anderson did all he

could to settle the outstanding difficulties, but to no avail. The discussion went on for a long time among the people themselves, and I was thinking that the matter would never be amicably settled when suddenly we were told that a satisfactory agreement had been reached. The oppressor was to give a pig to the most influential of the oppressed chiefs, and the latter was to give a pig to the oppressor ! This seemed perfectly conclusive of the trouble to everyone, and his late enemies were fed by the oppressor and slept in his house. Such is the importance attached to the reciprocal gift of a pig !

The only domestic animals commonly kept by the natives besides the pig are the dog and the fowl. The dog was unknown when Captain Cook visited the islands, but he left some of both sexes with the natives. I do not know to what extent, if at all, the natives' dogs of to-day are descended from those left by Captain Cook. Of the fowl I will only say that the natives do not appear to draw a very clear line of demarcation between a freshly-laid and a partially incubated egg.

The gardens in which the natives grow their vegetables strike the eye as peculiarly without order, since the plants, except sometimes the yams, are not grown in straight lines. The staple article of diet in most parts of the group is the yam, which the natives train up long vertical poles in their gardens. Where there is running water taro is also cultivated.

Fig. 8. A House in Sakau.
(*Photo by Mr. J. de H. Morel.*)

[*To face p.* 32.

On the west coast of Espiritu Santo there is a rudimentary irrigation system for the taro, longitudinally split bamboos serving as gutters to convey the water to where it is wanted on the terraces. The natives also cultivate many other tropical productions, including bananas, papaws and coconuts.

As regards houses, there is some variation in the style of architecture in the different islands and parts of islands. Thus in the mountains on the west side of Espiritu Santo, cane-grass replaces the sago-palm leaves which are usual elsewhere in the thatching of the roof. In general it may be said that the houses are tent-shaped, with the roof coming within a foot of the ground on each side, and there is no internal division into rooms. The height of the ridge-pole is commonly about seven feet, and since the slope of the roof is steep, one can only stand upright near the middle line of the house. (Fig. 8.)

I will describe in detail the construction of a Sakau house, basing my description on one at the village of Ladhansi. (Fig. 9.) The lengths, diameters, etc., given are estimates, not measurements.

The house is 15 paces long by 5 paces wide by 7 feet high. The ridge-pole, some 8 in. in diameter, is supported on three 4 in. uprights, one at the front, one in the middle, and one near the back of the house, the two latter being Y-shaped above and thus holding the ridge-pole securely. There are 47 roof-supports, formed of 2 in. bamboos. Each of these extends from just above the ground on one side to just above the ground on the other, and is half cut away in the middle

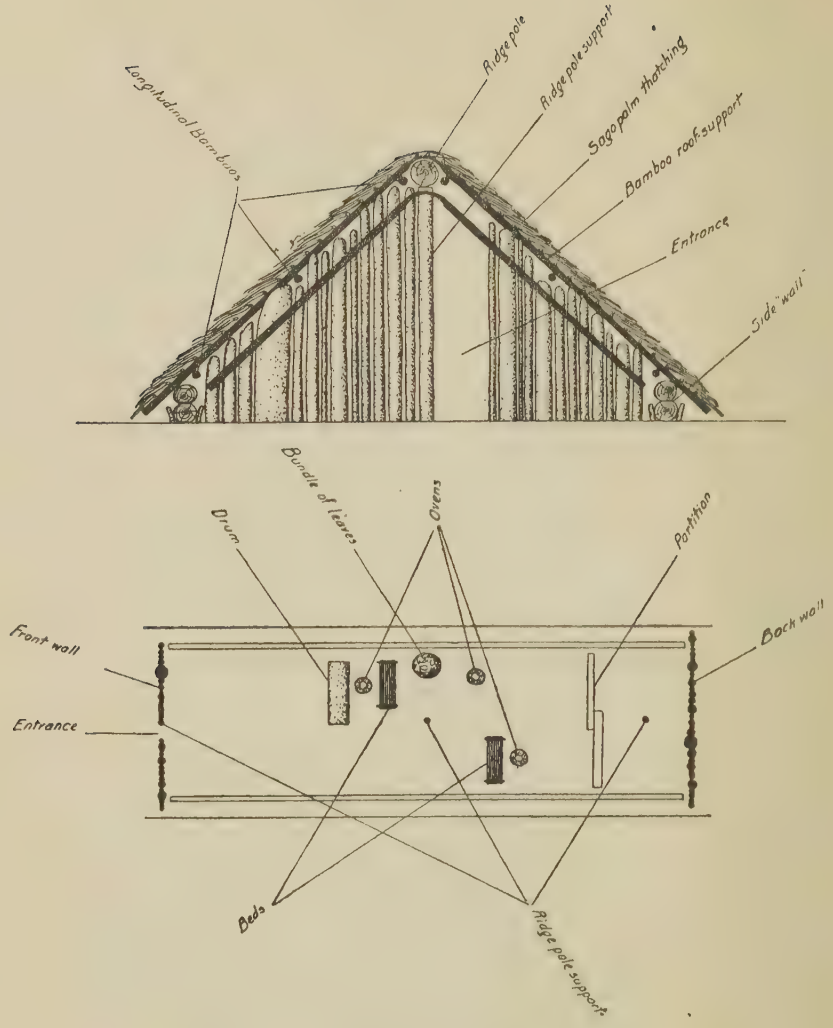



FIG. 9. DIAGRAM OF A SAKAU HOUSE.
(Elevation of front and interior.)

to allow it to bend over the ridge-pole. These roof-supports are not attached to the ridge-pole, but are firmly lashed to two longitudinal bamboos which run beside it from one end of the house to the other, and also to two other longitudinal bamboos on each side of the house, one near the ground and the other half-way up. In addition to the 47 bamboo roof-supports there are five equally-spaced hardwood supports on each side.

The roof-supports rest below, not upon the ground, but upon two 6 in. hardwood logs placed longitudinally, one upon the other, down each side of the house, the lower being fixed in position by pegs. These logs represent the side walls of the house, which the reader will observe are only one foot high.

I have not seen a roof being made, but it would appear that the leaflets of one side of a leaf of the sago-palm are approximated to those of the other, and that the thatching units thus formed are laid one above the other like overlapping tiles and lashed to the bamboo roof-supports. The roof extends about 1 ft. 6 in. beyond both front and back walls. The top of the roof, above the ridge-pole, is thatched with banana leaves, which are held in position by short sticks half broken in the middle and arched over (not shown in Fig. 9). A tuft of sago-leaf thatching sticks out from the roof at the back of the house in the middle line.

The back wall consists of 29 uprights fixed in the ground, varying in diameter from 1½ in. to a foot. The front also consists of 29 uprights,[1] but there is an entrance just wide enough to admit a man to the right (as one enters) of the foremost upright supporting the ridge-pole. This is the only aperture in the house, there being nothing

[1] The uprights nearest the sides of the house are omitted in the upper diagram of Fig. 9 in order to expose the "walls".

corresponding to a window. The entrance is blocked up when necessary by a number of loose 3 in. bamboos, which are placed inside the house and rest above against a bamboo which crosses the entrance near the roof.

At Tungwi the houses are minute. With the exception of one house, probably the men's club-house, the tops of the roofs come only as high as my shoulder. There are few parts of the world where people live in such little dwellings.

The lower part of Fig. 9 is a diagram of the interior of the house at Ladhansi described above.

In connexion with my investigation of the white influences in Sakau, I sometimes made a careful inventory of everything found within native houses, and I print below my inventory of this one :—

| *Of native origin.* | *Of white origin.* |
|---|---|
| *On floor.* | |
| 2 beds. | 5 muskets. |
| 3 ovens. | 2 hatchets. |
| Bundles of leaves (for the ovens). | 1 empty meat-tin. |
| 1 carved pudding-platter. | 2 small bundles of calico. |
| 1 uncarved „ „ | |
| 1 drum. | |
| Logs for sitting on. | |

*Stuck in roof or hanging from it.*

1 pudding pestle.
1 coconut scraper (made of polished coconut-shell).
1 half coconut-shell.
1 hollow fruit serving as a flask.
6 baskets.
2 hanks and 1 roll of rope.

1 bow.
6 lower jaws of pigs.
2 pigs' tusks.
2 ribs of pig.
2 bunches of fowls' tail-feathers, the vanes cut so as to make ornaments.
Sprigs of leaves.

Some of these things require comment. The beds consist of about a dozen bamboos laid alongside one another and resting on a log at each end. They are most uncomfortable, for they are so short that the sleeper's legs project far beyond them. The ovens are simply excavations in the floor lined with stones. Cooking is achieved by heating stones in the fire, raking out the fire, arranging the food (tied up in large leaves) among the hot stones, and covering everything up with leaves to retain the heat. Certain of the leaves in which food is tied up for cooking give it a delicious flavour. It will be noticed that the ovens are beside the beds. Fires are usually kept burning in them throughout the night to keep the sleeper warm. I have seen a man most fearfully burned by falling from his bed into the fire in his sleep. The pudding-platters are of wood, with a projection, sometimes ornamented, at each end. Rope is formed of strips of bark twisted together. The drum is simply a large log laboriously hollowed out through a narrow slit along one side.

Pottery is only made on the west coast of Espiritu Santo : elsewhere nothing can be boiled or stewed.

The smelting of metals from their ores is quite unknown ; so although iron occurs, it is not used. The natives nowadays have knives obtained from the traders. The sale of knives is the one really useful way in which the arrival of Europeans has benefited the natives ; against it must be weighed all the suffering from disease and the resulting depopulation. But this is a subject to which a special chapter must be devoted.

## Chapter III

# DEPOPULATION

THERE is no doubt that there has been a great decrease in the number of natives in nearly all the islands of the New Hebrides during the last half-century. What is the cause of this decline? Unfortunately depopulation is a subject on which little work has been done that can lay any just claim to be called scientific. A psychologist visits a depopulated area and pronounces depopulation to be due to psychological causes; a missionary points to polygamy, an atheist to the dying out of polygamy, a malaria-expert to mosquitoes and an anthropologist to loss of power by chiefs: yet guess-work, powerfully aided by preconception, would be a more fitting name than Science for their investigations.

I therefore consider it an advantage rather than the reverse that I came to the islands with no better equipment for the study of depopulation than a thorough education in biology and scientific method. I will ask the reader to be generous enough not to attribute the emphasis I lay on sex-ratio wholly to my interest in sex-biology!

The only reliable way of tackling the problem appeared to be to take a relatively small area and

study it in detail. My detailed study consisted in getting vital statistics of all the natives of Sakau and of a sufficient number of those of the rest of Espiritu Santo to be representative. I have tried as far as possible to find what are and what are not causes of depopulation by analysis of the figures obtained. There are some problems, such as the extent of abortion, that cannot be answered in this way ; but to some of the most important questions, such as whether the number of children is proportionately greater in Christian or heathen villages, a quite definite answer is given.

There have been anthropologists who have sought to eludicate all the problems of savage life by residing peacefully in a Christianized village and getting information from the brightest of the natives who have been taught in the Mission school. Depopulation is not a problem which can be resolved in this pleasant way. The prime requirements are a pair of effective legs, a little tact in dealing with natives, and a ready toleration of discomfort. A few extracts from my journal will give an idea of the type of work involved. Let us take up the thread at Ladhansi, on one of my trips into the interior.

*Tuesday, 12th April*, 1927. From sleeping on the earth floor I was very cold during the night, although I wore my pyjamas and woollen waistcoat in addition to vest and trousers. I have not brought a blanket. The natives talked endlessly through the night. On

rising I breakfasted on a cup of tea, a tin of fruit salad, and a little bread that I had brought with me, and then collected for a while. It was not a long walk to Tungwi. No white man has been at Ladhansi or Tungwi before : of this I am assured by the natives. Two boys (aged perhaps 8 and 10), never having seen a white man before, stared at me without ceasing. My afternoon's collecting was cut short by very heavy rain, accompanied by the most violent thunderstorm I have ever experienced. Nialis [one of my three carriers] was literally terrified, and sat stone still throughout with his head between his knees, to the great merriment of Willy Pipē [another carrier]. I read a little pocket edition I had brought with me till at last it cleared up. I then collected for a while aided by a bushman and a small boy. I have got a lot of new insects here and at Ladhansi, and have also examined an intersex pig and taken vital statistics.

The most noticeable thing about this village is the lowness of the houses. I am sleeping in the highest, and cannot stand upright even in the middle of it ; while the roofs of the others only come up to my shoulder. As at Ladhansi, the tops of the roofs are thatched with banana leaves . . . In the house I only saw the following articles of white origin :—1 bottle, 1 hatchet, 1 piece of tin roughly pierced to form a coconut-grater.

Extraordinary manifestations of paternal and filial affection are shown at this village. The small boys

sit with men (presumably their fathers), embracing them and holding them by the arm, while the men pat their heads and look paternal. They sit together thus for a long time in perfect contentment.

Towards evening I was strolling up and down in front of the house reading my book when, looking up, I saw that one of the small boys was strutting about in imitation of myself! It is seldom that New Hebrideans mimic anyone.

For dinner I was only given three baked sweet potatoes.

*Wednesday, 13th April*, 1927. It was cold again last night. The floor combined hardness with great unevenness, and arms and legs were continually falling " asleep " and waking up to the accompaniment of a severe attack of " pins-and-needles ". No food was offered me in the morning. I ate some stale bread and dried apples, but still felt very hungry. In the end I got the people to give me some bananas. They are distinctly inhospitable here.

It was an uneventful walk to Loweriē, Yaro's village. On the way Nialis surprised me by eating a banana complete with skin. We passed through deserted village after deserted village. This part of the country must have held a huge population in the past—and not so very long ago, for all the villages were populated in Nialis' life-time. " All 'e die finish."

We arrived at Loweriē not long after midday, and were very hospitably received with presents of bread-

Fig. 10. A Leper and His House.
*(Photo by the Author.)*

[*To face p.* 42.

fruit and mandarins. Afterwards it rained hard and I obtained detailed population figures not only for Lowerië but also for several surrounding villages . .

Before dinner I met the *vüriar*, Yaro, who looks about fifty. He is lighter-skinned than the other natives, and has a kindly but most aristocratic face . . .

I dined on hot baked breadfruit. A native brought banana leaves for me to sleep on and most carefully arranged a pudding-platter for my pillow. He thought the first platter he tried in some way unsuitable, and replaced it with another with great solicitude!

Another extract from my journal records an unpleasant incident.

*Monday, 27th June*, 1927. Zita, Morel and I went with four natives to Lwata and Watvagol, to get population figures and photographs. At Watvagol we could find no one from whom to elicit information, so Zita and I went searching round on our own. At last we came upon a man sitting alone by his minute house—so low that he would have to crawl to enter it. (Fig. 10.) We shook hands, called the others as interpreters, and got the information we required. We noticed that one of our informant's toes had nearly disappeared, and that there were some ghastly sores on his back. Zita suggested that he was a leper, but I scouted the idea, thinking that his toe was merely injured and his back attacked by yaws. On our return to the Mission station at Hog Harbour we told the Andersons that we had met this man,

Ngudh by name. There was immediately a wild rush for the lysol bottle. Ngudh was a leper of long standing ! We hurried off and washed our hands in lysol, threw off our clothes for thorough washing, and finally washed ourselves all over . . .

On one occasion my guide suddenly absconded and my only carrier and I were left miles from anywhere without camping equipment or sufficient food or water in a part of the island which neither of us knew, surrounded as always by the interminable forest. I will not weary the reader with an account of how we raced against the setting sun, utterly exhausted, how we threw away the odometer which we could push no further, how we dropped a very valuable aneroid barometer and had not the energy to look for it, and how after ten hours' march we finally came upon a village just after the sun had set.

These abstracts from my journal will have acquainted the reader with the sort of work involved in getting vital statistics of a primitive people. My method was to visit personally as many of the villages as possible, and to obtain details of those villages which I had not time to visit from responsible natives well acquainted with them. On entering a new village I collected several of the men and explained my object through one of my carriers, who knew both pidgin-English and the language spoken in the village. I then obtained particulars of every family in the village from them, classifying each male as a boy, bachelor, married man

or widower, and each female as a girl, spinster, married woman or widow. In order to be able to compare sex-ratios of children with sex-ratios of adults, it was necessary that the age at which the boy became a bachelor should be as nearly as possible the same as that at which a girl became a spinster. Unfortunately the natives do not reckon age in years. Marriageable age is no criterion, for males marry at much greater ages than females. I finally decided to take the age at which hairs appear on the face in the case of males, and marriageable age in the case of females. I think these ages correspond rather closely, and perhaps approximate to fifteen years.

It might be thought that a census with any pretensions to accuracy could not be taken without my seeing each person individually, and indeed I think that this would be so in most communities. But anyone who knows the Melanesian is aware of the intense interest he takes in his relationship to the other members of his village. I found that they delighted in giving me the information I required, and when I was quite weary after more than an hour's session, they would be as interested as ever. In the case of young babies, there was sometimes some argument as to whether they were male or female; but I did not record him or her till someone was found who was certain. In order to check the accuracy of my method, I usually pretended, at the end of the census-taking in each village, to have failed to write down one or more

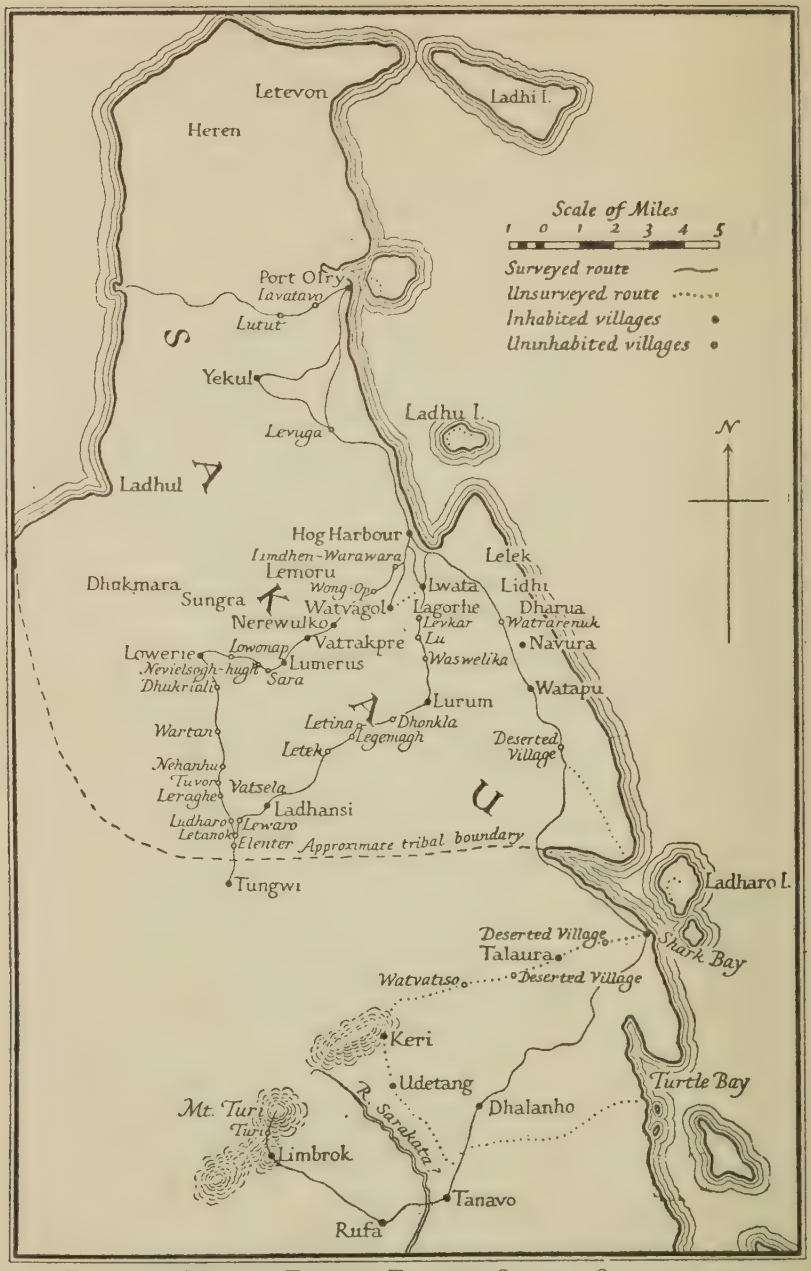



FIG. 11. MAP OF EASTERN ESPIRITU SANTO. SHOWING THE AUTHOR'S ROUTES.

*By kind permission of the Royal Geographical Society.*

*page* 46]

families, and asked them to tell me them again. In every case the details given were the same as had been given before.

Fig. 11 is a map of eastern Espiritu Santo, the coast-line being taken partly from the Admiralty Chart and partly from the map of the French Ministère des Colonies. The villages are put in from my own compass survey, in the preparation of which I was assisted at first by Mr. A. B. MacPhail. We measured sometimes by odometer and sometimes by time on the march. The reader will understand that a quite accurate map cannot be made in this way. Existing villages are put in in ordinary type and the sites of former villages in italics. Mr. S. J. Baker most kindly drew the map from our survey note-books, and the draughtsmen of the Royal Geographical Society have redrawn it for publication. The Society kindly allows it to be reproduced here.

The N.E. peninsula constitutes the district of Sakau. I found its southern boundary by noticing where the language changed. The language of Sakau is very different from the other languages of Espiritu Santo, and indeed from all the languages of the rest of the New Hebrides, particularly in the large number of consonants in the words and the prevalence of "gh" and "dh".[1] Presumably the ancestors of the Sakau people invaded Espiritu Santo separately from the ancestors of the other natives of the island, for not

[1] See footnote to p. 22.

only in language but also in physical structure and folklore they are peculiar. For this reason I made a separate census of them with separate calculations of sex-ratio, etc. There is no such sharp distinction between the people of S.E. Espiritu Santo and the remaining inhabitants of the island, so I took an arbitary N. and S. line as my boundary.

I had not time to make a census of the western half of Espiritu Santo, but I took figures from a few villages here and there in this part and used them, in conjunction with the figures from S.E. Espiritu Santo, for calculation of sex-ratio, etc., in the whole of the island other than Sakau.

To sum up, I took a census of Sakau and S.E. Espiritu Santo, and got sufficient figures from western Espiritu Santo to be able to compare Sakau with the whole of the rest of the island in the matter of sex-ratio, etc.

All my figures are given in my paper in the *Journal of the Royal Anthropological Institute*.[1] Table I is a summary of them.

The most striking point in the census is the very high sex-ratio (159 males to 100 females) in Sakau, with the resultant very great proportion of bachelors, who are nearly as numerous as the married men, despite the small amount of polygamy. The amount of polygamy can of course be seen by comparing the number of married men with the number of married women.

[1] Vol. lviii, p. 279.

Table I. Summary of Census.

| | *Sakau.* | *Rest of Espiritu Santo.* |
|---|---|---|
| Total population . . . | 691 | —[1] |
| Sex-ratio (number of males to 100 females) . . . . | 159 | 115 |
| Number of bachelors per 100 adult females . . . . | 40 | 17 |
| Number of spinsters per 100 adult females . . . . . | 7 | 4 |
| Percentage of adult males lacking wives (bachelors and widowers) | 53 | 31 |
| Number of married women to 100 married men in heathen villages | 110 | 114 |
| Number of children per 100 adult females . . . . | 128[2] | 126[2] |

[1] Total population of S.E. Espiritu Santo . . . 229
Population of villages studied in other parts of Espiritu Santo . . . . . 249
Approximation to total population of Espiritu Santo (see text) . . . . . 4090

[2] These figures are not really comparable with similar ones for European Countries, as New Hebrideans die younger, and the proportion of children in the census is thus increased. The figures are surprisingly low when this is taken into consideration, and when it is remembered that nearly all females marry, mostly at perhaps fifteen years of age.

Another very important point in the census is the small number of children per 100 adult women. Both these points are discussed further on.

In order to form some estimate of the total population of Espiritu Santo, I asked the Rev. F. G. Bowie for the censuses of the western half, which he took, with the assistance of natives, in 1910 and 1916. Mr. Bowie kindly put all his information at my disposal. The total figure obtained by adding his census (1910 and 1916) of western Espiritu Santo to mine (1927) of eastern, is 4,090. I think that our censuses together cover nearly the whole of Espiritu Santo, except some villages in the interior of the N.W. peninsula. The figure includes eleven small villages in the N.W. peninsula which I counted, but Mr. Bowie did not. Probably there has been a considerable decrease in the population of western Espiritu Santo since Mr. Bowie made his censuses.

*The extent of depopulation.*—Of the extent of depopulation in eastern Espiritu Santo it is impossible to speak with any accuracy, simply because no one has ever made a census before. Mr. T. O. Thomas, who has lived at Hog Harbour for nearly a quarter of a century, thinks that when he first came to the island there were perhaps ten times as many people in Sakau, four or five hundred people sometimes mustering on his beach at a time. Certainly depopulation has been enormous. I had explored the interior very little when I noticed that here and there amid the dense forest are patches, each a few acres in extent, which are free from trees and clothed with vegetation only to the height of about four feet. The dominant plants

in these patches are Ipomoea peltata and Ipomoea sp., which grow almost to the exclusion of other species except Plectrianthus Forsteri, a Labiate.[1] The very large heart-shaped leaves of Ipomoea give these patches a very characteristic appearance, for it climbs the forest trees bordering the patches to their summits, so that whether one looks up or down, one sees nothing but a mass of giant heart-shaped leaves. At first I sought some physical explanation of these patches, such as a difference of soil or water-supply from the rest of the country. But my carriers soon corrected me. They are the sites of old native gardens belonging to villages whose inhabitants have died off. Sometimes a few coconut or banana trees, or a dilapidated fence, are still to be seen to prove the truth of my carriers' explanation. Often my carriers had been well acquainted with the village when it was well populated. In nearly every case they were able to tell me the name of the extinct village. The extinct village sites are recorded in italics in my map. The reader cannot fail to be appalled by the depopulation which they bespeak. It is true that in a few cases (e.g. Lavatavo and Turi) the inhabitants have not died off, but have gone elsewhere as a result of the death of their chief or the exhaustion of their land ; but in the vast majority of cases I was told that the inhabitants had simply died.

[1] I am very much indebted to Mr. R. Good for determining these species.

I hope that in ten or twenty years someone will take another census of Sakau and S.E. Espiritu Santo, so that an accurate statement of the change in population may be obtained.

*The causes of depopulation.*—In order to avoid the necessity for a long discussion of the literature on the causes of depopulation in the Pacific in general and of the New Hebrides in particular, I have prepared a table which summarizes it. (Table 2.) I will take in turn the causes which have been supposed to be operative, and will consider how far each applies to Espiritu Santo.

*Apathy due to loss of old customs.*—Rivers considered this the most important cause of depopulation in Melanesia. He supposed that owing to the apathy due to loss of old customs, the natives' resistance to disease (at all times small owing to their suggestibility) was even further decreased ; and that having lost interest in life and the incentive to have large families, they extended the practice of abortion, which formerly they had used mainly to prevent illegitimacy. I discuss this theory fully under the heading *abortion.* Roberts,[1] following Rivers, lays great stress upon this as a cause of depopulation. For instance he says " . . . if the study of native races the world over yields any conclusion, it is that a people bereft of a past, a race scorning its achievements, however petty they may

[1] Roberts, S. H., 1927, *Population problems of the Pacific,* Routledge, London.

TABLE 2.

Views of recent authors on the causes of depopulation in Melanesia. The amount of stress that each author lays upon each cause is represented by the number of daggers (†). (Some of the supposed causes have no marks against them. This indicates that they have been brought forward as causes of depopulation, but have not been considered by the authors named to act as such in the New Hebrides.)

| | Buxton.[1] | Durrad.[2] | Lambert.[3] | Rivers.[2] | Speiser.[2] | Myself. |
|---|---|---|---|---|---|---|
| Apathy due to loss of old customs | | | † | ††† | | |
| Loss of power by chiefs | | | | | †† | |
| Lassitude due to abundance of food | | | | | | |
| Intertribal wars | † | | | | | |
| Lack of selection | | | | | | |
| Firearms | | | | † | †† | |
| Recruiting | † | †† | † | †† | †† | |
| Endemic diseases | †† | | | | † | † |
| Introduced diseases | ††† | ††† | † | †† | ††† | ††† |
| Lack of hygiene | | | † | | | |
| Breaking down of primitive quarantine barriers | † | | † | | | |
| European clothing | † | ††† | | † | † | |
| Unnatural sexual practices | | | | | | |
| Too close intermarriage | | † | | | | |
| Ill-treatment of women | † | | | | | |
| Female sterility | | | | | †† | |
| Abortion | † | †† | | †† | †† | ††† |
| Infant mortality | † | †† | | | †† | |
| Infanticide | | | | | | |
| High sex-ratio | †† | | | | | †† |
| Cannibalism | | | | | | |
| Tinned meats | | | | | † | |
| Alcohol | † | † | † | † | ††† | |
| Drugs | | | | | | |
| Lack of education | | | † | | | |

[1] Buxton, P. A., 1926, *The depopulation of the New Hebrides and other parts of Melanesia*, Trans. Roy. Soc. Trop. Med. and Hyg., vol xix, p. 420.

[2] Rivers, W. H. R. (edited by), 1922, *Essays on the depopulation of Melanesia*, Cambridge University Press.

[3] Lambert, S. M., 1926, *Health Survey of the New Hebrides*. Bach, Suva (Fiji).

be in foreign eyes, must die". Again, " . . . psychological despair . . . is the basic cause of depopulation" among lowly peoples, and " . . . depopulation is due primarily to psychological causes . . . Medical . . . remedies . . . merely skim the surface". Precisely how this apathy is supposed to affect the population is not exactly explained, though certain passages seem to indicate that he thinks that it has a direct effect, causing death from " delusional melancholia", rather than an indirect one (such as encouraging abortion or affecting male or female fecundity). This is certainly not a cause of depopulation in Espiritu Santo. Many native deaths occurred round about me, but dysentery, influenza and tuberculosis were the causes, not delusional melancholia. Roberts supports Rivers when he maintains that influenza has a particularly lethal effect owing to the apathy caused by loss of old customs. My experience is directly contrary to this. During a severe influenza epidemic which occurred while I was in Espiritu Santo, the morality was far greater in the heathen villages, which retain their old customs, than in the Mission village of Hog Harbour, though everyone in this village got the disease. Further, when a heathen native gets ill, he considers that his illness is due not to natural causes, but to the supernatural powers of some other person or persons. A sort of fatalism assails him, and death is far more likely to occur than if he were a rational being. It is much more likely

that this fatalism would kill a heathen native suffering from influenza, than that " delusional melancholia " caused by loss of old customs would kill a Christianized one. During the very epidemic to which I referred above, one of the most important chiefs in the N.E. of Espiritu Santo died of influenza. His friends naïvely went to the District Agent and asked to be allowed to murder certain natives in a neighbouring village who had caused their chief's death by magic !

Roberts does not hesitate to assume a causal connexion between the retention of the old custom of head-hunting in Malaita in the Solomons and a flourishing population, and much of what he writes is in the same vein. Yet we should undoubtedly regard a sociologist as leaving the realms of science for those of mysticism if he were to draw any conclusions about fluctuations in the numbers of our poorer classes from their having sufficient virility to carry through a general strike. It appears to me that argument of this sort is clearly inadmissible. Roberts pushes it to extremes when he tries to account for the *increase* in population among the Europeanized, lazy, vicious Wallis Islanders by saying that they must have " a certain spirit or tenacity, which cannot be analysed " but which nevertheless " is the root of the problem " !!

*Lassitude due to abundance of food.*—Lassitude is supposed to have the same effect as the apathy discussed above. Roberts says that the natives of part of Dutch New Guinea are dying out on account of the prevalence of the sago palm, because

this plant supplies them with abundance of food with the very minimum expenditure of energy. The same argument applies against this theory as against the loss-of-old-customs theory. The question hardly arises in Espiritu Santo, for although the country is so fertile that the natives have not got to work hard to provide sufficient food, nevertheless they are keen agriculturalists.

*Loss of power by chiefs.*—I regard this as a result rather than a cause of depopulation. When an island becomes depopulated, the importance of the chiefs of highest rank cannot remain so great, simply because there are fewer people for them to rule.

*Inter-tribal wars.*—The unceasing vendettas were mentioned in the last chapter. Since no pitched battles take place, the mortality from this cause is not great.

*Lack of selection.*—Roberts thinks that "the elimination of the unfit in their constant warfare" had a good effect upon the Maories. This cannot apply in Espiritu Santo, where anyone may be killed by a shot in the back when he least expects it, to avenge the death of someone who had been killed by a member of his village. His fitness or unfitness does not influence his chances of death from this cause.

*Firearms.*—All the heathen of Sakau carry muskets (mostly muzzle-loading Sniders); and though bullets are not plentiful, there are enough to go round. A Sakau heathen never leaves his village without his rifle. These rifles are used for shooting one another and nothing else. But, as was explained above, the

number of deaths is small. Probably it was almost as great when clubs and bows and arrows were used for the same purpose : for the muskets are nearly always used at point-blank range, at which the more primitive weapons are also effective.

*Recruiting*.—The natives recruit for work on plantations very little nowadays. Since the times of the scandalous "black-birding" of natives for the Queensland sugar plantations, hardly any natives have left the group. A few natives recruit for work on plantations in the New Hebrides themselves, and some people consider that this causes depopulation, owing to their not wishing to have children on plantations. This I believe not to be the case in Espiritu Santo, firstly because natives of this island seldom recruit, and secondly because several pregnant women have actually come to Mr. Thomas's plantation at Hog Harbour particularly to bear children, having heard of many successful deliveries there.

*Endemic diseases*.—Buxton considers that malaria is quite an important cause of depopulation in the New Hebrides, but my own experience, as well as that of those with whom I have discussed the matter in Espiritu Santo, is opposed to this belief ; for although certainly it is very prevalent, it does not appear often to be lethal. Nearly every native contracts yaws, usually in childhood, and this disease and malaria probably reduce the resistance to other more dangerous ones.

*Introduced diseases.*—Undoubtedly introduced diseases constitute a very important cause of depopulation. Even Roberts, who pins so much faith to psychological causes, thinks that introduced diseases are very important in the case of the New Hebrides. Influenza, measles, dysentery and tuberculosis probably cause most deaths. Influenza, measles and certain other diseases are far more lethal than they are among the people of the great continents of the world, who have been selected during the ages for partial immunity to these diseases. In the villages of Wus and Sauriki, situated close together on the west coast of Espiritu Santo, there were formerly 278 natives. Measles, whooping cough and mumps were introduced from other islands in 1900 and 1902. Only 32 were left alive, of whom many subsequently died of tuberculosis.[1] Other diseases are less common, but very destructive. At Tasiriki, on the west coast of Espiritu Santo, there were between 70 and 80 natives in 1922. A man landed from another island with meningitis. 36 contracted the disease, of whom 33 died. The remaining three each lost the use of the left ear and eye and one of them subsequently became mad.[1] In my own experience, which only extends over a year, influenza and dysentery (probably amoebic) have been the chief causes of death. No one with actual experience of death in the New Hebrides will attribute depopulation to "delusional melancholia".

[1] Information from Mrs. F. G. Bowie.

The Tongkinese and Annamese who have recently been brought to the New Hebrides to work on plantations are probably responsible for certain epidemics which have not been identified.

*Lack of hygiene.*—This cannot be regarded as a cause of depopulation in itself, for of course the natives had no better hygiene in the days when the islands supported a very large population. But, as Mr. J. de H. Morel has pointed out to me, the introduced diseases require particularly careful attention to hygiene for their prevention, and thus it is only since the arrival of Europeans that hygiene has become important. In particular the almost complete absence of ventilation in the houses, which are often crowded with people, must aid the rapid spread of influenza and measles. Dysentery, once introduced, could not fail to establish itself where flies have access both to fæces and food.

*Breaking down of primitive quarantine barriers.*—To some small extent the hostility of one set of villages to another may prevent the spread of disease in Sakau and formerly over most of Espiritu Santo. But there has always been trade in pigs between islands and parts of islands, so that no effective quarantine barrier can be said ever to have existed.

*European clothing.*—The clothing of the heathen of Sakau was described in the second chapter. In the Christian villages the men often wear cotton trousers and vests and the women a cotton frock. It

has been argued that the wearing of these clothes renders them liable to disease, as they do not change them when they get wet. I doubt whether this has been substantiated. No information exists, to my knowledge, which could throw light on the truth or untruth of this argument. Nevertheless the native cannot fail to lose self-respect on changing from the dignified savage, justly proud of his or her physical development, to the hideously (and usually dirtily) clothed convert.

*Unnatural sexual practices* are probably not indulged in to any great extent except on plantations.

*Too close intermarriage* hardly occurs owing to the strict rules of exogamy which apply both in heathen and Christian villages.

*Ill-treatment of women.*—It is true that women do nearly all the carrying of food from gardens to villages, even when pregnant ; but I do not think that abortion is often thus caused. In some ways the men are more considerate than many Europeans, for the evils of one pregnancy following too quickly on another are prevented by a tapu against cohabitation too soon after childbirth.[1]

*Female sterility.*—Probably a good deal of promiscuous sexual intercourse is indulged in by the young women. This is held by some to cause female sterility. It is difficult to appraise its importance as a cause of depopulation.

[1] Information from Mr. T. O. Thomas.

*Abortion*.—Here, without a doubt, we have one of the most important causes of depopulation in both heathen and Christian villages. It is obtained by drinking infusions of the leaves of Dracaena and other plants, usually on instructions from the husbands.[1] As a result, the number of children per 100 adult females is only 128 in Sakau and 126 in the parts of the rest of Espiritu Santo studied, although more than 93% of the adult females of Sakau, and more than 96% of those of the rest of the island are, or have been, married. Why should the people of Espiritu Santo want to have smaller families than formerly? Is it that the loss of old customs has caused them, as Rivers supposed, to consider it useless to bring up children to live as dull lives as they?

Espiritu Santo is a particularly suitable island for the study of the effects of the loss of old customs consequent on the advent of white people, for there are wholly Christianized coast villages on the one hand, and some of the least tamed natives of the New Hebrides on the other, second only to the "Big Nambas" of Malekula in the retention of their savage ways. In place of the usual guess-work, a scientific study of the effects of loss of old customs on population can be made by comparing vital statistics in Christianized and heathen villages, and this was one of the main reasons why I made the census.

[1] Information from Mr. T. O. Thomas and Mr. W. Anderson.

For brevity I will refer in the sequel chiefly to Sakau, though the conditions are similar elsewhere.

In the whole of Sakau there are only seven Europeans, all living within a quarter of a mile of the coast. Of these only two at all commonly go more than half a mile inland. The natives from heathen villages quite close to missionaries' or traders' houses often come to the coast to get medicines or exchange foodstuffs for knives, tobacco, calico, etc., and occasionally their villages are visited by a missionary. As one goes further inland one comes to villages like Lowerie, which have a visit from a white man perhaps a dozen times in a decade. Others, such as Yekul, are visited less often. Others have been visited only once before, by a French surveying party. Others again have never been visited by a white man except myself. In these inland villages the children have never seen a white man before, and the women seldom or never. The women fly shrieking at one's approach. Perhaps one of the men has worked on a plantation before, but has gone back to his old life completely. As the reader of the second chapter will have found, the heathen of Sakau are practically unaffected by the existence of a few whites on their shores. As Buxton says, "in the interior of Santo . . . the people are still in a state of primitive savagery, just as they were centuries ago."

In the Christian villages, on the contrary, the life is in great part changed. The natives may see a white

man nearly every day of their lives. They buy pots and pans for cooking and eating. Their houses often have walls. A men's " club-house " exists, but women are said to have entered it. There is no chief-making, no dancing, no polygamy, no vendetta. The clothes worn have already been described. Instruction is given in reading, writing and arithmetic, and religious services are held on Sundays and other days. In a word, the European influence is very great.

Now if it were the loss of old customs that caused natives to wish to have small families and to secure their object by abortion, one would certainly expect to find smaller families in Christian than in heathen villages. The facts are given in Table 3. The fertility is shown as the number of children per 100 adult females. In Christian Sakau the number is 164 ; in heathen Sakau only 120. In the rest of Espiritu Santo the same condition holds. In the Christian villages examined there were 171 children to every 100 adult females ; in the heathen only 79. *It is not loss of old customs that is causing the people of Espiritu Santo to limit their families by abortion.*[1]

Why, then, should they wish to limit them ? I think their reason must be the appalling number of

[1] My figures definitely disprove Speiser's statement that " . . . the birth-rate is certainly no better [in Christian villages] than in the inland villages ". It must be remarked, however, that Speiser says frankly, " . . . in weighing the value of my observations it must be remembered that there are no trustworthy statistics. They must be accepted as . . . personal views . . ."

Table 3. The Number of Children per 100 Adult Females.[1]

| | Heathen villages. | Christian villages. |
|---|---|---|
| Sakau . . . . | 120 | 164 |
| Rest of Santo . . . | 79 | 171 |

Table 4. Sex-ratio (Number of Males to 100 Females).

| | Young | Adult. | Whole population. |
|---|---|---|---|
| Sakau . . | 169 | 155 | 159 |
| Rest of Santo . | 141 | 102 | 115 |

Table 5. The Sex-Ratio of Children in Heathen and Christian Villages.[1]

| | Heathen villages. | Christian villages. |
|---|---|---|
| Sakau . . . . | 172 | 135 |
| Rest of Santo . . . | 141 | 141 |

[1] Port Olry, Ladhi Island, and Tavunemala are excluded, as being of mixed and doubtful religion.

deaths caused by diseases brought in by Europeans. The people think it useless to produce children who will only die in epidemics. The state of affairs was very clearly put to me by a native woman on another island. When I questioned her about the recent deaths in her village, she indicated all the children who were sitting round about us and said, " Close up all picinniny here 'e die finish " (all these children will die soon). This feeling that it is useless to produce children who will only die young, is, I believe, the cause of the limitation of families by abortion in Espiritu Santo. Probably it is on account of the medical aid given by missionaries that the people in Christian villages do not feel quite so hopeless, and therefore, by procuring abortion less often, have rather larger families.

Rivers sometimes noticed large families in villages where there was European influence, and tried to explain away this apparent refutation of his theory by supposing that Christian fervour was replacing the old excitements of savage life in the psychological make-up of the people. Let anyone who thinks that Christian fervour does actually replace it in Espiritu Santo accompany me from a Mission village to the savage chief-making ceremony described in the second chapter of this book. He will not retain his views.

I think there can be no doubt that, as far as Espiritu Santo is concerned, my figures definitely disprove Rivers' theory of depopulation through loss of old customs.

*Infant mortality.*—I have no figures giving annual infant mortality for any part of Espiritu Santo, nor any evidence as to whether influenza, measles and dysentery are more lethal to children than to adults in the New Hebrides. Epidemics certainly kill large numbers of children. The custom of feeding babies whose mothers are unable to suckle them on chewed yam and sweet potato is probably harmful. I doubt whether carelessness or harsh treatment are often to blame for infant deaths. New Hebrideans are much attached to their children and show very real grief at their death (as opposed to the ceremonial wailing in which they have to indulge on the death of more distant relations). In the heathen villages parents do not beat their children, but a higher civilization has brought this custom to the Christianized ones.

*Infanticide.*—In heathen Sakau the sex-ratio of children is 172, while in the Christian part it is only 135, which might be considered to point to female infanticide in the heathen part. This question is touched on in the next section. I did not hear of the deliberate killing of a single child.

*High sex-ratio.*—This I believe to be an important factor in the depopulation of Sakau, where I found the ratio to be 159 males to 100 females. (See Table 4.)

I think this is the second highest sex-ratio recorded of any people in the world at the present time. The reader should remember that Great Britain, Ireland, France, Belgium, Holland, Denmark, Norway, Sweden, Germany, Austria, Hungary, Russia, Switzerland, Spain and Italy all have sex-ratios of less than 100 males to 100 females. I know of only four civilized

or semi-civilized countries (China, Russian Turkestan, Korea and the Caucasus) which have a ratio higher than 106. Turning to uncivilized races, the peoples of Papua and Melanesia probably have the highest sex-ratios (i.e. the greatest excess of males) of any ; yet out of 36 censuses taken in other parts of the New Hebrides (1916–24),[1] the Bismarck Archipelago (1921),[2] the Solomon Islands (1921),[2] and N.E. New Guinea (1921),[2] only six were above 140, and only one was higher than Sakau. The Anir Islands in the Bismarck Archipelago constitute the exception, with a sex-ratio of 161 (in a population of 704). I have no information as to whether imported male labour provides an easy explanation of the high sex-ratio in the Anir Islands. In past time the Todas of the Nilgiri Hills in India exceeded even this figure, by intensive female infanticide.

In order to show the effect of high and low sex-ratios on population, let us imagine three uninhabited islands, each simultaneously discovered and colonized by fifty men and fifty women aged about twenty years. Let us assume the islands sufficiently large, fertile and healthy to hold large populations ; that the female colonists and their female descendants marry ; that they produce on the average three children each (not counting abortions, still-births and infant

[1] Buxton, P. A., 1926. See footnote, p. 53.

[2] Pitt-Rivers, G. H. L.-F., 1927, *The Clash of Culture and the Contact of Races*, Routledge, London.

deaths) ; that the average age of child-bearing is thirty years ; that two-thirds of the children of both sexes live to attain twenty years ; and that the average age at death of those who survive to twenty years is forty-five. Further, let us suppose that a census is taken on each island every thirty years.

In the case of the first island, let us assume a sex-ratio (of children and adults) of 100 males to 100 females ; of the second, only 90 males to 100 females ; of the third, 160 males to 100 females, approximately the sex-ratio of Sakau. The graph (Fig. 12) gives the censuses taken on each island every thirty years. The points are joined to aid the eye.

In the first island, with equal numbers of males and females, the population remains unchanged. In the second, where polygamy has been going on, so that no woman has failed to produce children from lack of a husband, the population has grown in 300 years from 100 to 160.[1] But in the island where the sex-ratio is 160, the population is reduced in the same period to 10—one-tenth of what it was ! No race could fail to decline with such a sex-ratio, unless the birth-rate were very high.

Pitt-Rivers[2] thinks that an increase in sex-ratio may cause decline in quite another way. He attributes the decline to the increase of monogamy attendant on increase in sex-

[1] It is obvious that in a monogamous country any deviation of the sex-ratio from 100 in either direction must result, other things being equal, in a reduced population or a reduced rate of increase.

[2] See footnote on p. 67.

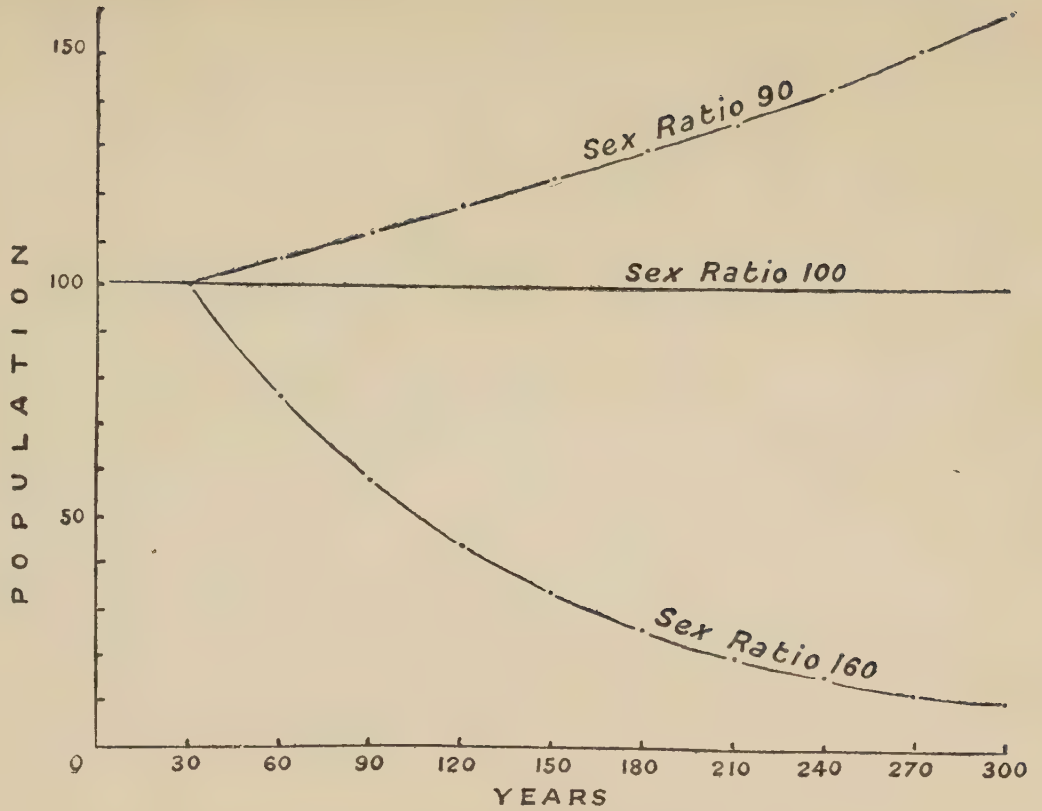



FIG. 12. GRAPH SHOWING THE EFFECTS OF SEX-RATIO ON POPULATION.
*By kind permission of the Royal Anthropological Institute.*

[page 69

ratio, pointing out that monogamy results in loss of freedom from cohabitation by pregnant and lactating women and in an increase in promiscuity, which he supposes to cause sterility. The objection to this theory is that monogamy is often correlated with an increasing population. Mr. T. O. Thomas suggested to me that increasing monogamy, in a people accustomed to polygamy, might result in depopulation in yet another way. When a man has several wives, he does not object to one or more of them becoming pregnant ; but when he has only one, he is denied the domestic, agricultural and sexual services of a wife while the latter is in the later stages of pregnancy and at the beginning at least of lactation. He thinks that abortion is always procured at the instigation of the husband.

Great preponderance of female deaths would of course account for the high sex-ratio of Sakau, and for this reason in making the censuses of Hog Harbour, Lwata and Watvagol (three Sakau villages), I listed the dead brothers, sisters, husbands and wives in addition to the present inhabitants. Unfortunately these three villages were unsuitable ones for the purpose, for the sex-ratio in them was not nearly so great as in the rest of Sakau. The figures obtained (13 dead boys to 15 dead girls, and 25 dead men to 23 dead women) show that there has been little differential mortality in these villages. Whether there is in the rest of Sakau, I cannot say ; but it would be a most strange thing if there were an excess of female deaths, for an excess of male deaths is the rule all over the world.

The ratio would be understandable if there were any evidence of female infanticide, but I never heard of a case. I cannot say that it does not exist, for it is a custom which would be likely to be kept secret.

Nevertheless it seems rather unlikely that fathers should kill their daughters, since they are of such great service as labourers and later bring such high prices in pigs when bartered to bridegrooms. Another point is that in the Mission village of Hog Harbour, where there is certainly no infanticide, the sex-ratio of children is 135. This is considerably less than that of Sakau as a whole, but it proves that female infanticide is not the whole cause of the high sex-ratio, if indeed it is one at all. In the rest of Espiritu Santo the sex-ratio of children is precisely the same (141) in heathen and Christian villages, so that one cannot suppose that female infanticide is an important factor. (See Table 5.)

Both in Sakau as a whole and in the parts of the rest of Espiritu Santo studied, the sex-ratio of children is considerably higher than that of adults. (This does not apply to Hog Harbour.) Possibly this is caused by the greater average longevity of women than men ; possible the sex-ratio is for some unexplained reason actually getting higher.

*Cannibalism* certainly still exists, as was pointed out in the second chapter. But since the natives do not kill people in order to eat them, but only eat them when they have killed them for other reasons, cannibalism does not affect population.

*Tinned meats.*—Roberts lays stress on tinned meats as a source of depopulation. I do not know whether he supposes that they kill people outright, or render them less fertile,

or increase "delusional melancholia". They are little used in Espiritu Santo even in Christian villages, and practically not at all in heathen ones. I have never heard of a case of ptomaine poisoning in Espiritu Santo resulting from meat being left in the opened tin before being eaten.

*Alcohol* is sold (illegally) by the French planters to natives working on their plantations. Since the vast majority of the natives of Espiritu Santo do not work on plantations, alcohol cannot be an important factor in depopulation. Little or none finds its way to heathen villages.

*Drugs.*—The only native intoxicant of the New Hebrides is kava. Although wild kava grows abundantly as a weed in clearings, I have not seen it cultivated in Espiritu Santo, and little or none is drunk. No intoxicants other than alcohol have to my knowledge been imported into Espiritu Santo for sale to the natives.

*Lack of education*, mentioned as a cause of depopulation by Lambert, can hardly be so considered, when it is remembered that there was no education in the days when the population was flourishing!

I may summarize this section by saying that I believe that depopulation in Espiritu Santo is due to diseases brought by Europeans and to abortion, which is procured because the natives are depressed by the large number of deaths from these diseases. Malaria and yaws probably reduce the resistance to these diseases. In Sakau the high sex-ratio is a contributory cause.

*Why prevent depopulation?* I venture to think that a hundred years hence we of this age will be considered nothing short of vandals for allowing

primitive peoples to be depopulated and their cultures to be replaced by a ghastly caricature of our own. To many Europeans these primitive folk are simply " niggers ", with all that that derogatory term connotes, and they and their culture are not worth saving.

Despite our self-satisfaction at our great money-making civilization, most of us would be appalled if we saw works of art being destroyed so that their component materials might be sold for profit. We even protect by laws those animals whose anatomy is particularly interesting. Yet we think nothing of allowing the complex systems which constitute primitive society to be destroyed. It has taken scores of generations for these systems to develop ; we allow them to collapse in one or two, and almost blot out the peoples themselves in addition. One needs to study social anthropology to get a glimpse of how complicated the life of a savage may be. Let the superior European tussle for a while with a classificatory system of relationship, and find how hopelessly dense he would appear if he were a " nigger " himself and had not only to know in exactly what relationship he stood to everyone with whom he came in contact, but precisely how he must treat each one according to his relationship. Let him try with only the rudest implements to grow his own foodstuffs and build his house. Let him even try to walk with the unaffected grace of a savage. In a word, let

him try to become less ignorant and more capable of judging what he has previously assumed must be destroyed in the name of commercial development and missionary endeavour.

Let me be perfectly plain in my contention. I do not think, for the reasons I have given earlier in this chapter, that the loss of old customs causes depopulation. But I do think that both the people and their culture are worth preserving, both on account of the intense anthropological interest of their system of society and on account of the (in many ways) delightful natures which their system has called into being. Let us not destroy their system and with it their cheerfulness, their honesty (as regards theft), their humanity to the helpless, their interest in animals and plants, their self-respect. Those whose knowledge is superficial have heard of the killing of old people and have been shocked by it. Let them live among the people and find that they give food willingly to those who cannot get it for themselves, and only kill suffering old people to put them out of their misery when asked by their "victims" to do so. Let us remember that our own "humane" system is to keep such unfortunate sufferers alive, as though we were anxious that they should suffer as long as possible.

I hope the reader will not get the impression that the New Hebridean is a sort of angel upon earth; far from it. The prostitution of wives, the vendettas, the unreliability of their natures, these and other vices

and shortcomings are conspicuous. But the good outweighs the bad.

*Remedies for depopulation.*—I think there are two possible ways in which depopulation could be remedied. The first I may describe as the administrative, the second as the philanthropic method. I am afraid that the chances of either being performed are very small, since nearly everyone will prefer well-tested methods, even when their very testing has proved their inadequacy, to what will be described as impracticable schemes.

I will take the administrative scheme first. It has the disadvantage that missionaries and planters, who disagree in everything else, would unite in condemning it.

An island which has few or no white men on it and little or no land owned by whites should be selected. Gaua, one of the Banks group, at the northern end of the archipelago, would be suitable. If any man not a native were living on it, he should be compensated by the Government and removed. If anyone not a native held land on it, he should be compensated and his land given back to the natives. In the case of Gaua, this would not be expensive. When I visited the island in 1927 there were two Japanese and no whites on it. A little land in a very bad state of cultivation belongs to a company which has no white resident representative. The island is roughly circular in outline, with a diameter of about

twelve miles. There are supposed to be about 600 native inhabitants.

Every native temporarily resident on another island should be given the opportunity to return, and every native wishing to leave the island should be helped by the Government to do so. (I am inclined to doubt whether any would leave.) It should then be made illegal for anyone, native or not, to come within a mile of the island for twenty years, with the exception of a small party who would visit the island directly it had been thus quarantined. The party, consisting of a doctor and at least one other, would visit every part of the island. The doctor would not leave until everyone suffering from diseases brought in by whites was cured. (Tuberculosis patients would have to be excepted.) A careful census would also be made. They would then leave the island and not return till nearly twenty years later, when they (or more probably their substitutes) would investigate the health of the natives and make another census. If the effect were a markedly increased population, the quarantine might be renewed and a similar quarantine started on other islands. By that time all the planters on the remaining islands will probably have secured indentured labour from various parts of the world, so that they would hardly be affected by their recruiting grounds in the New Hebrides being cut down.

The quarantine would have to be preserved by occasional unexpected visits from a Government

Fig. 13. Arrow-heads from Gaua. The shaft of each arrow (not shown in the photo) is of cane. Between the shaft and the point is a length of tree-fern wood, which is attached to the point by a complicated binding of fibre. The point of the left-hand arrow is of human bone; that of the middle arrow is a spine of the sting-ray; that of the right-hand arrow was said by natives to be of turtle-shell.

*(Photo by the Author.)*

Fig. 15. Pteropus eotinus (above) and Pt. geddiei.

*(Photos by the Author.* *See page* 88.*)*

[*To face p.* 76.

vessel and a system of heavy punishments for offenders. The District Agents would also have to make sure, when witnessing the " mark " made by natives when recruiting for plantations, that they were not recruited from the island concerned.

I do not think that the expense of the experiment can be counted against it, for there is apparently a large amount of money available for the solution of New Hebridean problems. Recently an enormously expensive commission visited the islands in a man-o'-war to further the interests of the British planters.

Some will object that it would be unfair to the natives of the quarantined island to deny them knives, calico and tobacco. A moment's thought rules out this objection. How can one weigh the petty advantage (if advantage it be) of these commodities against all the suffering from introduced diseases ? The necessity to make cutting instruments and to weave cloth for themselves would add greatly to the interest of their lives. The arrows they use now are tipped with wire. If they were quarantined, skilled craftsmen might fashion again the beautiful arrows that used to be made in Gaua. (Fig. 13.) Many native arts and crafts which are now tending to decay would be revived.

The Missions would of course regard it as very unfair that they should be denied access to islands on which there are converts : but I consider that the

most imperative need of the New Hebrideans is not a new religion but their old health : and when the white man's crime of nearly blotting out a primitive, but in many ways delightful, race has to some extent been atoned by the restoration of their population, then, if ever, the time has come to try to substitute a new code of morals, a new religious history, and a new set of superstitions for the old. Some of the missionaries do splendid work in combating disease ; but the most serious of the diseases which they combat were and are brought to the New Hebrides and spread from island to island by their vessels and those of other white men. Durrad, himself a missionary, says,[1] " . . . the ' Southern Cross ' [the vessel of the Melanesian Mission] is one of the chief agents in the distribution of pneumonia germs. This was noticed long ago by the natives ". His description of terrible outbreaks of pneumonia and influenza, with great mortality, following upon visits from this vessel, makes shocking reading. He describes how Bishop Patteson visited the island of Mota one day and landed a party of natives whom he had brought with him on the " Southern Cross ". He found the inhabitants in good health. In a fortnight he returned. " A great mortality was going on, dysentery and great prostration of strength from severe influenza. About twenty-five adults were dead already." In the next two and a half days " twenty-seven adults died, fifty-two in all,

[1] In the book edited by Rivers quoted in the footnote to p. 53.

and many, many more were dying emaciated, coughing, fainting ". Comment would be superfluous.

The second or "philanthropic" scheme for remedying depopulation is as follows: The public should be made acquainted with the facts and a subscription opened. If sufficient money were obtained, much the same sort of quarantine as that just described would be arranged, but by persuasion instead of by force. All the planters and traders on neighbouring islands would be asked, in return for monetary compensation, to enter into a bond that neither they nor their employees should visit the island. The missionaries would be asked to visit the island as little as possible, and then only when they were certain that they were free from infectious diseases. They would be asked never to land a single native from another island upon it, and never more than one missionary at a time if it could possibly be avoided. It is easy to scoff at missionaries, and many do so; but my own experience is that both the Presbyterian and the Church of England Missions have the cause of the native very much at heart. I believe that if the facts were put strongly before them, they would be prepared to agree to these proposals in the case of a small island. There would be a medical visit and census-taking at the beginning of the quarantine, just as in the case of the administrative scheme.

Possibly it might be advantageous, with either scheme, for a small party of whites to land on the island

every three years or so and distribute prizes to parents for the additions to families. The difficulty would be to choose prizes which were at once easily carried about and yet unlikely to disturb native culture. Pigs would be excellent if they were not so difficult to bring from one village to another. The whites would have to be certain of their freedom from infectious diseases.

As compared with continental areas, oceanic islands present both a great advantage and a great disadvantage in the matters with which I have dealt in this chapter. On the one hand, the presence of sea all round makes the strict quarantining of a small area possible as it never could be on a continent. On the other hand, the inhabitants of continents have some immunity to such diseases as influenza and measles which the natives of oceanic islands lack. On continents, those who have lacked the necessary immunity have died and left few or no offspring. On oceanic islands, where these diseases were unknown till the advent of Europeans, no such selection for immunity has taken place, and the people succumb when the diseases are introduced. We have let the great disadvantage under which oceanic islanders labour have full play ; let us now enable them to profit by their great advantage.

## Chapter IV
# THE FAUNA

THE fauna of any part of the globe is determined mainly by its climate and by the opportunity that animals have had to get there. Let us take the second cause first. Why are there no monkeys, elephants or antelopes in Madagascar, while these animals abound[1] in the neighbouring continent of Africa? Simply because Madagascar, which was previously joined to Africa, became separated from that continent before the animals named had evolved, or at any rate before they had spread to that part of Africa.

Wallace, in his *Island Life*, classified islands as ancient continental islands (e.g. Madagascar), recent continental islands (e.g. Great Britain), and oceanic islands (e.g. the Galapagos Islands). The two former agree in having at one time been connected with a continent. In ancient continental islands the fauna tends to resemble that which occupied the continent at the time when the island became separated from the mainland. This is well exemplified in Madagascar, where the chief Mammals are lemurs, insectivores and civets, all primitive groups in comparison with the monkeys, lions, leopards, zebras, rhinoceroses, elephants, buffaloes, giraffes and antelopes, which later

[1] Or used to abound.

evolved on the mainland of Africa or migrated there from elsewhere.

Recent continental islands have, naturally enough, nearly the same fauna as the adjoining continent. The chief difference from the mainland is usually the absence of a few species, which can be accounted for largely by the island being likely, from its smaller size, to present less diversity of habitat.

Oceanic islands are islands which have sprung up in the ocean by volcanic action or coral growth or both, far from any great land mass. Each individual terrestrial animal inhabiting an oceanic island must have found its way there across the sea or must be descended from individuals which did so. Small wonder that one does not find elephants or lions or monkeys on oceanic islands ! As one might expect, the mammalian fauna is very poor, being usually confined to bats and a few small rodents which may occasionally get adrift from a continent on floating masses of timber carried out to sea by rivers, and drifted about the ocean till eventually they chance to run aground on an island shore.

There is no good evidence of a large continent ever having existed in the tropical Pacific, nor that the New Hebrides were ever joined to the Australian continent, so we may fairly regard them as oceanic islands. Their fauna is a little richer than that of many oceanic islands, since there are neighbouring archipelagoes of islands which may have served as

stepping-stones for immigrants. We must remember, however, that on Wegener's celebrated theory, according to which the continents slide about over the globe, the New Hebrides may be fragments left behind during the north-westerly sliding of New Guinea. If this theory be true, the paucity of the fauna of the New Hebrides in comparison with that of New Guinea is accounted for by the fact that New Guinea acquired its present rich fauna from Australia and Malay after the New Hebrides had separated from it.

Let us turn now to the climate of the New Hebrides. Climate must obviously have exerted a powerful influence on the fauna of the islands, for if animals unsuited to hot damp regions were to find their way there, they certainly could not establish themselves.

Fig. 14 shows graphically how the mean temperature (i.e. the average of the daily maxima and minima) of each month compares with that of England. The New Hebridean temperatures are for 1927 at Hog Harbour, Espiritu Santo. The English ones are the average of 97 years at Oxford. The rainfall is compared in Table 6, the 1927 figures for Hog Harbour being compared with the mean of 111 years at Oxford. I wish to thank Mr. T. O. Thomas and Mr. O. Stevens for much help with the meteorological observations at Hog Harbour, and the officials of the Radcliffe Observatory for giving me the Oxford figures.

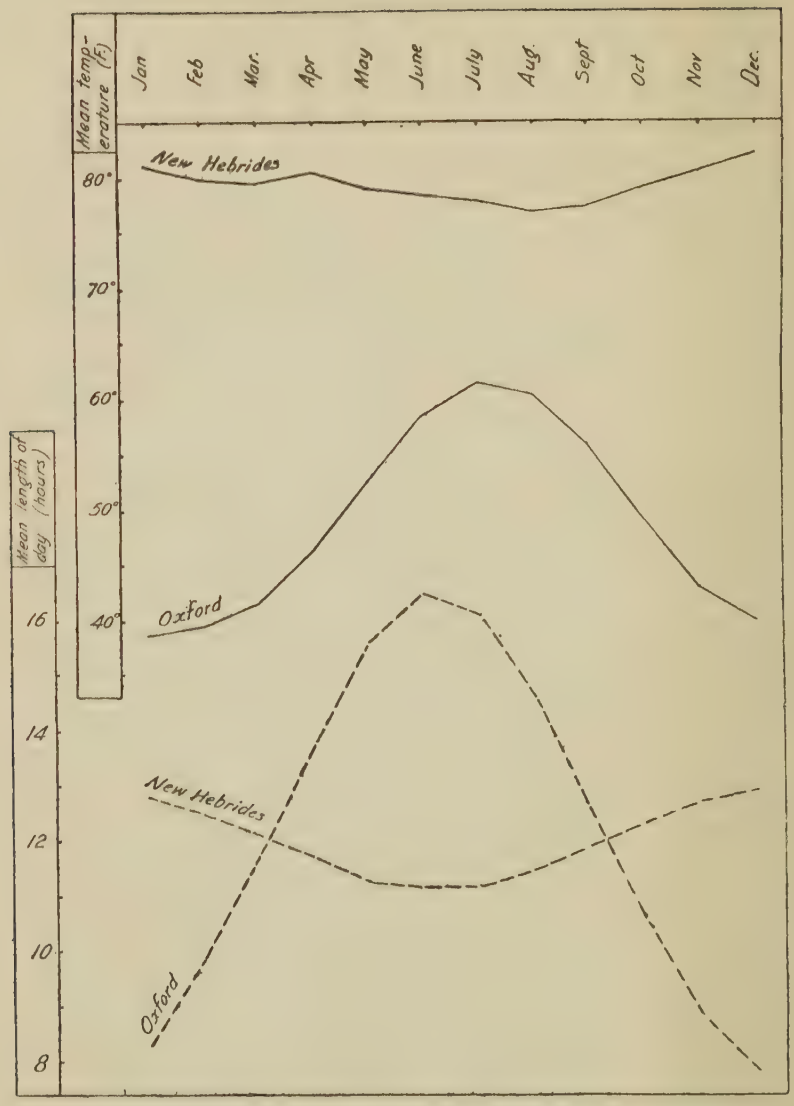



FIG. 14. GRAPH COMPARING THE CLIMATE OF ESPIRITU SANTO WITH THAT OF OXFORD.

Table 6. Rainfall of Hog Harbour, New Hebrides, and Oxford Compared (to nearest $\frac{1}{10}$th inch).

| | Jan. | Feb. | Mar. | Apr. | May. | June. |
|---|---|---|---|---|---|---|
| Hog Harbour, New Hebrides | 19·7 | 14·9 | 20·7 | 11·3 | 6·8 | 4·2 |
| Oxford . . . . | 2·0 | 1·7 | 1·7 | 1·8 | 2·0 | 2·2 |

| | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|
| Hog Harbour, New Hebrides | 4·4 | 5·9 | 13·1 | 14·5 | 7·6 | ? |
| Oxford . . . . | 2·6 | 2·5 | 2·5 | 2·9 | 2·3 | 2·2 |

The graph and the Table show at a glance what a consistently hot, damp climate the New Hebrides have. The temperature rises to about 86° F. each day and sinks to about 73° F. each night. There is an average rainfall of about a third of an inch each day.

The result is a typical tropical rain-forest (Fig. 1), which covers the whole of Espiritu Santo except small grassy areas on the northern slopes of the chain of mountains running along the west coast and north-west peninsula. The forest consists mainly of trees some thirty to forty feet high, about eight inches in diameter, and five yards or so apart. Often the stems are buttressed near the ground, or adventitious roots spring out in all directions. These modifications are no doubt adaptations to withstand hurricanes. The leaves are almost confined to the upper third of the trees, so that a fairly open space is left between them and the undergrowth. Some of the trees are much larger, with great buttresses reaching twelve feet from the ground, and huge

banyans occur here and there. The undergrowth consists mainly of shrubs two to five feet high, of which the dominant forms are a dicotyledon and a monocotyledon which grow in a curiously similar way. Their unbranched stems, fringed with lanceolate opposite leaves about six inches long, spring separately from the ground or from a very short common stem, and bend over so that the upper half is almost horizontal. It is presumably on account of lack of light that there is seldom much growth of herbs on the rich leafy humus beneath the shrubs. Ferns grow epiphytically on the branches of the larger trees, which also support great lianas whose sap provides a welcome drink to the thirsty traveller. Clumps of bamboos occasionally break the monotony of the vegetation, and the unpleasantly common nettle-tree advertises itself by the red midribs of its large dark green leaves. Sandalwood and the kauri pine occur, but neither is abundant.

Along the shore grow trees which are not found inland. In exposed situations the lofty Casuarina, with its intensely hard dark wood, replaces the several strand-trees which prefer the shelter afforded by bays. It may be mentioned in passing that some of these strand-trees, such as Barringtonia speciosa L. and Calophyllum inophyllum L., show a curious ill-adaptation to habitat. Since they are distributed by their fruits floating on the ocean, they never occur far from high-tide mark. Yet they are not fully perfected

for life in this situation ; for, growing out towards the light, they very commonly overbalance and fall into the sea.

The reader is referred to the Appendix for a list of the terrestrial and freshwater vertebrates of the New Hebrides.

*Mammals.*—The Mammalian fauna is a characteristic one for a group of oceanic islands, for (excluding the feral pig) there are only bats and rats. There are no fewer than five species of fruit-bats, including an example of the remarkable tailed genus Notopteris, which is confined to New Guinea and Western Oceania. Three of the four species of Pteropus are found nowhere outside the New Hebrides. In other words, the original species of fruit-bats which found their way to the New Hebrides long ago have evolved into three new species within the confines of the New Hebrides. It is their isolation which has made this evolution possible, for the species have not been kept constant by continual interbreeding with individuals of the parent species. The origin of new species proceeds apace on oceanic islands, owing to the isolation of animals which find their way there. This naturally applies particularly to species which have especial difficulty in getting across the ocean. It is a distinctly remarkable circumstance that no less than three species of Pteropus have evolved within the group, for one would have thought that fruit-bats could pass relatively easily from one group of islands to another.

A new species (Pt. bakeri) was described by Mr. Oldfield Thomas from my specimens.[1] Mr. Thomas thinks also that my Pt. eotinus, from Espiritu Santo, may be subspecifically distinct from the type specimens from Maewo ; but there are not sufficient specimens from Maewo to determine the point. One of my specimens of this species is shown in Fig. 15, together with Pt. geddiei, which is the largest and most abundant fruit-bat in the group. (See Plate facing p. 76.) Hundreds of Pt. geddiei hang together upside down in large trees, often gently flapping their wings to keep themselves cool, and when disturbed uttering cries not unlike the cry made by seagulls when food is thrown to them. At night they leave their tree-top home to feed on papaws or other fruit.

The two insectivorous bats had not been recorded from the New Hebrides before my visit. Many of my specimens of them were captured by being struck deft blows with sticks by small native boys.

Rattus rattus, the common black rat, was no doubt introduced into the islands by shipping. The other rat, Rattus exulans, is widely distributed among the Pacific Islands. There is no evidence that it ever travels by ships, and its means of distribution are unknown. Floating timber seems the only possibility.

The pig, Sus papuensis (Fig. 16) was probably brought to the islands by the natives when first they came to them. It is mentioned by Captain Cook.

[1] For reference, see Appendix 3.

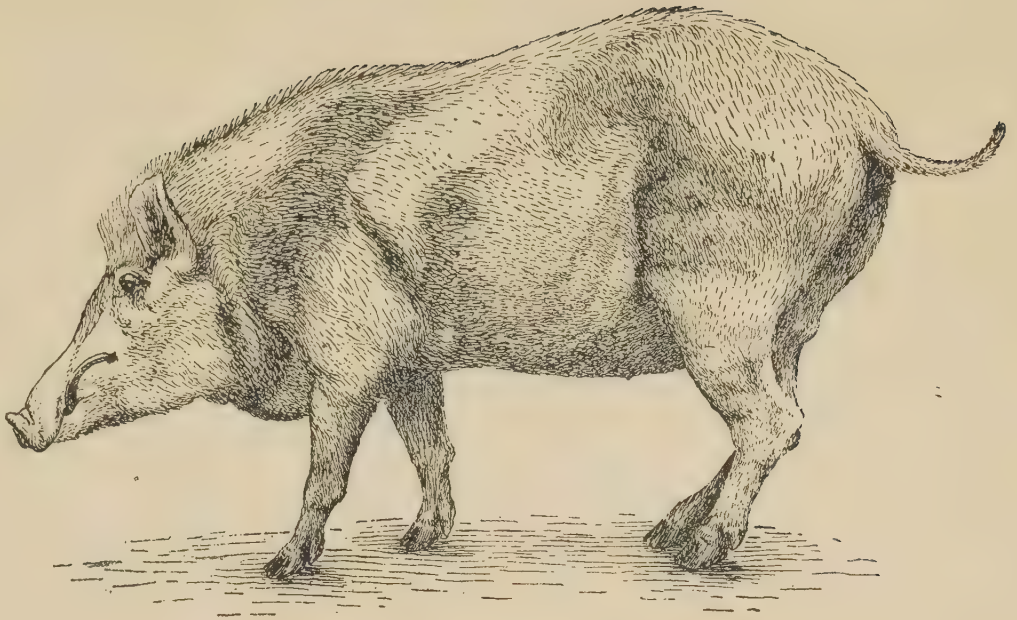


FIG. 16. SUS PAPUENSIS (an intersex).
*Drawn (from photographs) by Mr. S. J. Baker.*

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In addition to the domesticated ones, many are feral. In certain of the islands, notably Espiritu Santo and Gaua, quite a large proportion of them are intersexual, male and female characters being combined in the same individual. I made a special study of this most curious subject, to which Chapter 5 is devoted.

The feeding habits of these pigs are interesting. I once saw one snap up a live chicken and eat it. The natives of Sakau tell me that they sometimes eat snakes. I have myself seen them feed greedily on human fæces.

*Birds.*—Essentially the bird-fauna is Australian. Representatives occur of such characteristically Australian groups as the Mound-builders (Megapodidae) (Fig. 17), Brush-tongued Parrots (Trichoglossidae) (Fig. 19), Wood-swallows (Artamidae), and Honey-eaters (Meliphagidae). Flycatchers (Muscicapidae) and Pigeons (Columbiformes), which are well represented in Australia, though of course very far from being confined to that continent, are also well represented in the New Hebrides, which further agree with Australia in the absence of Finches (Fringillidae) and Woodpeckers (Picidae).

The chief difference from Australia is the absence of several groups which are highly characteristic, namely the Cassowary and Emu (Casuariiformes), Lyre-birds (Menuriformes), Bower-birds (Ptilonorhynchidae), Cockatoos (Cacatuidae) and true Parrots (Psittacidae).

Three genera occur which are absent from Australia.

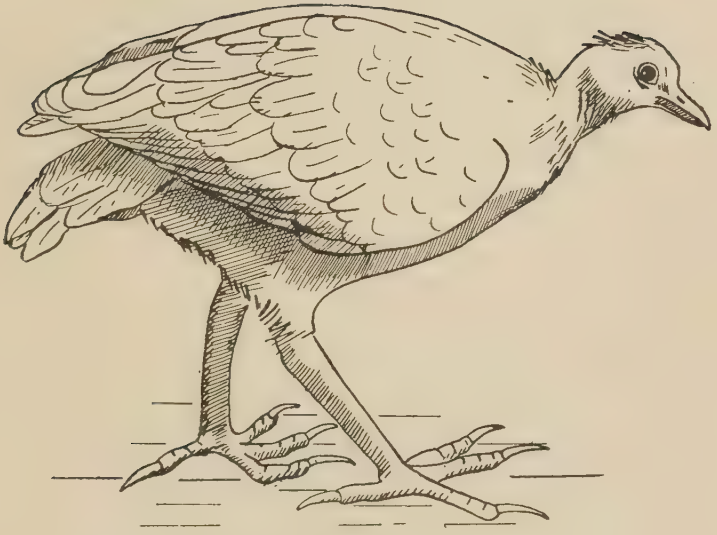

FIG. 17. MEGAPODIUS LAYARDI

*Drawn by Mrs. Z. Baker.*

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These are Turdus (Thrushes) (Fig. 18), Erythrura (Weaver-birds) (Fig. 19) and Aplonis (a genus of starlings). It is very strange to hear the familiar song of a thrush when all else in one's environment is so utterly unlike England, and stranger still to reflect that thrushes have spread down the Malay peninsula and through northern Melanesia to the New Hebrides, yet not a single species of the genus has penetrated into Australia.[1] Erythrura is a Malayan genus of the Weaver-bird family which has also spread to the New Hebrides, yet has missed Australia completely. Aplonis is a Polynesian and Melanesian genus, and therefore its absence from Australia is less surprising.

It is a remarkable fact that of the 53 species and sub-species of birds recorded in the list, no fewer than 37 are confined to the New Hebrides. This shows the powerful influence of isolation in the origin of species.

Rhinochetus jubatus of New Caledonia, the only member of the Heron-like family Rhinochetidae, is not represented in the New Hebrides.

I discovered a large new pigeon, Muskadivora bakeri Kinnear,[2] which seems to be confined to high elevations (above 3,000 feet) on the west coast of the island of Espiritu Santo. Its native name is " sopa ". Before I ascended into the mountains, I was told of

[1] Specimens introduced by man are of course excepted.
[2] For reference to Mr. Kinnear's paper, see Appendix 3.

Fig. 18. Turdus mareensis and Zosterops vatensis.
(*Photo by the Author.*)

Fig. 19. Trichoglossus hæmatodus and Erythrura cyanovirens.
(*Photo by the Author.*)

[*To face p.* 92.

its existence by the natives, so I offered a large reward for specimens. Soon after we had gained sufficient height, one of my carriers announced that he had shot two specimens of the "sopa". My elation subsided quickly when I saw that they were neatly plucked for eating! I only managed to secure one specimen afterwards, on which the description of the species is founded.

Turning now to the commonest birds of the New Hebrides, the little swift Collocalia uropygialis is one of the most abundant. The Pigeons (Columbiformes) are represented by a large number of species, of which Janthoenas vitiensis and the two species of Ptilinopus are probably as common as any. Trichoglossus haematodus (Fig. 19), one of the Brush-tongued Parrots, is often seen flying about in groups, uttering loud screeches. As one walks through the bush one constantly hears the distinctive notes of the thick-heads (Pachycephala), and at night the large strand-trees often swarm with little White-eyes (Zosterops vatensis) (Fig. 18), which sleep in pairs so soundly that they often remain where they are if shot at and missed.

*Lizards.*—Fourteen species of Lizards occur, all belonging to the widely distributed families of Geckos and Skinks. The New Hebrides constitute the most easterly point of distribution of three species (Gecko vittatus, Lygosoma cyanogaster and L. kordoanum). Agamidae and Varanidae, well represented in Australia,

do not occur. Brachylophus, an Iguanid which departs so far from the habit of that essentially American family as to live in Fiji, does not extend to the New Hebrides.

It is a remarkable fact that no fewer than ten of the fourteen species are absent from the adjacent land-mass of New Caledonia. These are Peropus oceanicus, P. vorax, Gecko vittatus, Lygosoma speiseri, L. noctua, L. cyanogaster, L. samoense, L. cyanurum, L. kordoanum and L. nigrum.

Lygosoma kordoanum and L. cyanurum are probably the most abundant of New Hebridean vertebrates. Everywhere except in the high mountains they scuttle before one on one's path. The largest of the Lygosomas are L. samoense and L. nigrum. The former is bright green with black markings above, the latter black with pink below. L. nigrum has the curious habit of repeatedly moving the head vertically up and down. L. samoense lives in trees, but often drops to the ground when pursued ; L. nigrum, on the contrary, lives on the ground but takes to trees to avoid capture. I noticed that the L. samoense of Gaua have far more black than those of Efate, and on my return I asked Mr. H. W. Parker to examine my material in this connexion. He finds that the Efate specimens have a crescentic black band on the parietals and nuchals, extending forwards on each side to the eye, and only a few scattered black spots on the body ; while the Gaua specimens commonly have a black band extending so as to cover almost all the upper surface of the head and nape, and the body has numerous black spots. One Gaua specimen is almost completely black above. The Espiritu Santo specimens are similar on the whole to those of Gaua.

Lygosoma speiseri is the only lizard which is confined to the New Hebrides. The species was named from specimens

from Ambrim. My specimens, from Efate, differ from the type ones in having 30–32 (instead 32–34) series of scales round the body and in having 40–46 (instead of 44–48) subdigital lamellae under the fourth toe. Further, the pale green dorso-lateral band and the black lateral band may be very indistinct or the latter may be broken up into irregular dark spots, and the black spots of the dorsal surface and sides may be wanting. In L. speiseri and L. samoense we seem to see the origin of species on the different islands of the group, consequent on geographical isolation. It is interesting to reflect that Darwin began to think deeply on the question of the origin of species as a result of his observation, made during the historic voyage of the " Beagle ", that a certain bird differed slightly on the different islands of the Galapagos group.

Ablepharus boutoni has an extraordinarily wide distribution from Africa across the Indian Ocean to Australia and the South Pacific.

Lepidodactylus lugubris is a little Gecko common in native houses. Gymnodactylus pelagicus is only found under stones. The other Geckos frequent trees.

*Snakes.*—In their snakes the New Hebrides have nothing in common with Australia, for there are no Pythoninae nor Colubrinae, and the only genus (Enygrus) belongs to a sub-family, the Boinae, which is essentially American. Although systematists allow only two species, there are many colour-varieties which have distinct native names. They are perfectly harmless, though viewed with horror (like the Geckos) by the natives. I found the remains of what appeared to be a thrush (Turdus mareensis) in the alimentary

canal of one specimen. Large individuals attain a length of about four feet. I caught one specimen at the height of about 1,700 feet on Mt. Turi in Espiritu Santo.

Crocodiles are extremely rare, but I saw the tracks of a large one on the sea-shore about a mile west of the mouth of the River Yoro in Espiritu Santo. One of my carriers had seen this animal, and described it to me as "big fella all same bullock, but 'e long fella; backside belong him 'e all same pine-apple; 'e no drown, 'e swim all same dog". Although I camped close to the spot for some days in the hope of getting a shot, I never saw it. It had made a path for itself, perhaps fifteen yards long, connecting a pond with the sea-shore. Mr. Parker considers that it probably belongs to the species C. porosus, which ranges from India through North Australia to Fiji.

*Amphibia.*—It is a very general rule that Amphibia are absent on oceanic islands, and the New Hebrides are no exception. Reptiles probably get dispersed largely by means of their eggs, which may be unharmed by a long sea-voyage on floating timber; but the eggs of Amphibia generally require to remain in fresh water, and fresh water is also necessary for the larvæ when they hatch out.

*Fishes.*—I am not aware that any collection of fresh-water fishes has ever been made before in the New Hebrides.[1] The list given in the appendix is simply

[1] One eel has previously been recorded.

that of the species obtained by myself. Nearly all of them were obtained near the mouth of the River Yoro (= Jordan), which flows into Big Bay in the island of Espiritu Santo. This is probably the largest river in the New Hebrides. The last fifty yards of it, where it flows out to sea, is only about twenty yards wide, but it is deep and extremely fast-flowing. It is curious to watch the rapid stream meet the incoming rollers. The fresh water rides over them as it flows out, and floating matter rushes outwards up and down over rollers whose apparent motion is of course inwards. It was at the wettest season of the year when I was at the mouth of the Yoro, and it was very difficult to swim across the narrow mouth. I had to face almost directly upstream and swim hard, yet I was carried right down unpleasantly near the open sea. I had occasion to swim across several times, but my carriers always preferred a tedious walk round to where they could ford across in safety.

Almost immediately above the narrow mouth, the Yoro widens into a large partly tidal basin, some two hundred yards across at the time of my visit. Above this again it divides into two main streams, which join perhaps three-quarters of a mile from the sea. The single stream thus formed is fifty or seventy-five yards across. Everywhere there are little sluggish side-streams and connecting streams, so that the whole river forms a most complicated system which it would take a long time to know properly. Never does the

water behave for long in the same way ; now it rushes knee-deep so fast that it is almost impossible to cross it despite its shallowness ; now it is slow-moving and profound, now narrow, now broad ; now rapid on one side and almost still on the other ; for ever divaricating and joining up again in maze-like complexity. The water at midstream about half a mile from the mouth at depth 1 ft. had the following characters on 29th April, 1927 : Mid-day temperature, 2·53° C. ; pH. 8·2 ; 0·193 gram solid constituents per litre.

Most of the fishes were taken with dynamite, while some were shot by natives with bow and arrow. There is no doubt that dynamite serves the naturalist better than any other tackle in securing freshwater fishes. I had a trammel-net and lines with me, but caught practically nothing with them. Dynamite is supplied for the purpose in cylinders of oiled paper about four inches long. One opens the oiled paper at one end and makes a hole in the dynamite with a pointed stick (not with any metal object). In this hole one places a detonating cap, which is a small cartridge half-filled with a detonating substance. Next one pushes the end of a length of fuse into the open end of the detonating cap, and ties the oiled paper round the fuse with string so as to make all secure. The length of the fuse is largely a matter of personal preference. The expert often likes to use the shortest possible fuse, in order to show his skill. This is

only advantageous with fishes that are frightened of the spluttering fuse. My experience in the Yoro was that all the fishes there swam *towards* the charge when it was thrown in, and therefore I got more fishes with a long fuse than with a short one. In a damp climate it is not always easy to light the fuse. A good method is to slit the free end of the fuse slightly and place the broken-off inflammable end of a match in the slit. I used to carry a hurricane lamp with me, and placed the end of the fuse in its flame to ignite it. The match-end of course caught fire at once, and lit the fuse even if it were slightly damp. There is no danger if one uses a fuse six inches or so long and throws the charge directly the fuse begins to splutter.

All the fishes obtained are probably capable of living in the sea. Some of them are known to have this capacity, and the others belong to essentially marine families. This being the case, there is little geographical isolation and hence no evolution of new species. Ambassis urotænia Bleek., Querimana crenilabis Forsk., and species of Gobius and Sicyopterus are perhaps the most abundant forms. I sometimes killed fifty or more fishes with a single charge of dynamite.

On approaching the Yoro one day about the end of April, 1927, I noticed what appeared to be a large rope lying under the surface of the water parallel to the edge and a few inches from it, extending an

indefinite distance up the river from near its mouth. Knowing that there could be no such rope so far from civilization, I investigated it more closely and found it to consist of a mass of little fishes all swimming upstream. These were of the genus Gobius, but unfortunately they were too young for the identification of the species.

At Tanavo in central Espiritu Santo I was surprised to find only one species of fish in the large river there. (I think this must be the river which is called Sarakata at its mouth, though I did not have the opportunity to trace it to the sea.) The natives attributed the absence of other fishes to a waterfall further downstream which they could not pass. The one species which could surmount this obstacle was Sicyopterus tæniurus Günth.

*Invertebrates.*—On these I shall only make a few random comments.

The large "robber-crab", Birgus, is not uncommon. (Fig. 20.) It is allied to the hermit-crabs of our coasts, and like them has asymmetrical abdominal appendages ; but whereas this asymmetry is advantageous to the hermit-crab, to fit it for life in the shell of a whelk, it seems to serve no purpose at all in Birgus, which lives in trees with its abdomen uncovered. It seems probable that its asymmetry is derived from an ancestor with the habits of a hermit-crab. Birgus is said in books to break open coconuts and eat the kernel. I made no observations on its feeding habits,

Fig. 20. Birgus latro and Xylotrupes gideon.
(*Photos by the Author.*)

[*To face p.* 100.

but I was assured by natives that it sometimes eats snakes ! At night it is a really formidable object on the native paths, for a bare foot is helpless against its massive pincers.

Birgus deposits its eggs in the sea, and the development of its larvæ takes place there. When once the young have taken to a terrestrial existence, they only return to the sea to spawn. Sometimes they occur at considerable distances from the sea. One specimen I found at an altitude of 380 feet. Such a clumsy creature must have felt at its wits' end when the irresistible call of the ocean came to it.

Xylotrupes gideon, a gigantic beetle, is the largest (though not the longest) insect in the New Hebrides. (Fig. 20.) I weighed 164 of these animals. The heaviest, a male, weighed no less than 10·290 grams. In the male there is a forked horn on the head and another on the prothorax,[1] the function of which is not known. I weighed both the head-horn and the prothoracic horn of seventy-seven males, and found that their weights are far more than proportionately smaller in small than in large specimens. The largest beetle, weighing 10·290 grams, had a prothoracic horn weighing 1,149 milligrams. Now the smallest male beetle weighed 2·505 grams, and one would therefore expect its prothoracic horn to weigh 280 milligrams, if it were of the same size proportionately

[1] The prothorax is the segment of the body which bears the first pair of legs.

to the body as in the largest beetle. Actually its prothoracic horn only weighed about 36 milligrams ! The smaller the beetle, the smaller *by far* the horn. The phenomenon of the disproportionately great size of certain parts in large individuals is of wide-spread occurrence, especially in Insects and Crustacea, and among the less essential organs.

Xylotrupes has one most peculiar habit in the New Hebrides. It tends to swarm in enormous numbers on Flamboyant trees (an introduced species). I have seen one of these trees alive with them. The natives say that they die as a result of feeding on this tree.

The longest insect in the New Hebrides is the stick-insect, Hermarchus uvarovi, one of the six new species of Orthoptera [1] which I found in the New Hebrides. The body of the type specimen measures no less than 17·2 cm. (about $6\frac{3}{4}$ inches).

By far the most dangerous animal in the New Hebrides is the mosquito Anopheles punctulatus Dönitz, which carries malaria and probably black-water fever and elephantiasis. In parts of Espiritu Santo, particularly near the mouth of the River Yoro and at Turtle Bay, it is very abundant ; in other parts, such as Hog Harbour, it is scarcely ever seen. When camping at the mouth of the Yoro I crawled into bed under my mosquito net at about 7 o'clock each night and stayed there nearly twelve hours to avoid it. It only bites between sundown and sunrise.

[1] For reference, see Appendix 3.

Its bite is more painful than that of Aëdes, the commonest mosquito of the New Hebrides. At Port Patteson, in the Banks group, I found twenty-three Anopheles inside my mosquito net one morning, gorged with blood. On one occasion, when camping with Mr. T. T. Barnard at Shark Bay in Espiritu Santo, he found 39 Anopheles in his net and I found fifteen in mine. Despite my being bitten so much I never contracted malaria, probably because I took five grains of quinine daily throughout my visits to the islands and for some weeks after.[1]

Malaria is the bane of the New Hebrides, yet it seems doubtful whether Anopheles can ever be stamped out there. If its larvæ lived in open expanses of water, the situation could be dealt with by putting paraffin on the surface, as has been done so successfully elsewhere ; but the New Hebridean Anopheles breeds largely in minute puddles formed where the water seeps out from the porous coral-limestone.

A. punctulatus is the only species of Anopheles that has been described from the whole of Melanesia south of New Britain. Particular interest is therefore attached to some Anopheles larvæ which I found in a puddle formed in a cart track at Hog Harbour, for Dr. P. A. Buxton finds that they are definitely not of the species *punctulatus*. More specimens must be obtained before it is possible to decide whether they constitute a new species or are to be referred to a known species which has not previously been recorded from Melanesia.

[1] I have had attacks of malaria since this was written. The disease must have been contracted in the New Hebrides, but it did not show itself until 18 months after I had left the islands.

A minor curse is the mosquito Aëdes variegatus var. hebrideus Edwards, which is by far the commonest mosquito in the islands. It is not abundant in the sun nor yet in the forest, but in the shade in coconut plantations it can make life a misery. In January, 1927, when in camp in a coconut plantation at Hog Harbour, I had to work in my tent with a net drawn over my topi on to my shoulders and my hands smeared with "sketofax". Even so my knees were badly bitten through silk trousers. I once made the experiment of exposing my right hand and wrist and holding it still for roughly a minute, to see how many would alight on it. No fewer than 21 alighted, nearly all of which started at once to draw blood. Aëdes seems to be more troublesome about 5 p.m. than at any other time, though it bites throughout the daytime. After 6.30 they are far less abundant, and after 7 they seldom bite at all. These observations were made in January. At other seasons of the year there are far less of these mosquitoes.

Aëdes variegatus is closely allied to the mosquito which transmits yellow fever. I do not know whether A. variegatus can transmit this disease. If so, and if a yellow fever patient were to enter the New Hebrides, the disease would run like wildfire through the islands.

It is because A. variegatus likes to breed in very small patches of water that it abounds on coconut plantations. To get the kernel, the natives split the coconut neatly in two, leaving the husk on the ground. Rain collects in these half-shells, and soon comes to hold a mass of wriggling Aëdes larvæ, which seem to revel in hot, alkaline water. I found the average noon temperature of the water in fifteen half-shells, mostly in the shade, to be 30·1° C. (86·2° F.). Larvæ were present in one shell at 33·0° C. (91·4° F.). The alkalinity was pH. 9·6, probably on account of the limestone soil which

spurts into the shells when it is raining. The mosquito could be kept in check by burning the shells of the coconut in the fire which serves to dry the kernel in the course of its conversion into copra.

Aëdes shuns large expanses of water, and is very rare at the mouth of the Yoro, despite the many stagnant backwaters.

Leaving these burdensome creatures, let us turn to a remarkable swarm of flying ants which occurred at Hog Harbour on 24th February, 1927. I may quote here from my journal :—

" We were sitting reading after our evening meal, when rather suddenly, at 6.53, a swarm of flying ants descended upon us. We have often had a few flying ants at our hurricane lamps before, but never very many. To-night they came in countless numbers, running rapidly in all directions over lamps, table, books, arms, faces, as well as inside clothes and in eyes and ears. In order to be able to give some concrete idea of their abundance, I took a board measuring 20 cm. by 12·5, and at intervals placed it on the table near my lamp to see how many ants would be crushed. In order to avoid personal error, I looked away before placing it on the table each time, and decided when to place it there without first looking to see whether many or few ants were present. In this way I obtained the following figures. These are only approximate, for the moment the board was removed to count the crushed ants, swarms of living ones rushed everywhere among the dead and dying,

thus making it impossible to enumerate the latter accurately.

| Approximate time. | No. of ants crushed. |
|---|---|
| p.m. | |
| 7.05 | 22 |
| 7.10 | 10 |
| 7.20 | 17 |
| 7.30 | 6 |
| 7.50 | 16 |
| 8.45 | 5 |
| 9.20 | 2 |

" Some of my specimens were collected by removing the stopper of my cyanide-jar and pushing in those that came on to the rim : others flew right into the jar of their own accord. At 9 o'clock I prepared myself a cup of lime-juice. When I came to drink it at 9.15, there were 22 drowned and drowning ants in it ; and this was long after the time at which they were most abundant.

" The most surprising part of the whole affair is that about five species of ant were concerned. It is not difficult to imagine that certain conditions of temperature, humidity or atmospheric pressure, or some other physical conditions, might call forth vast numbers of the sexual forms of one species ; but that the conditions should be identical for so many distinct species is remarkable in the extreme."

The same night swarms of ants were recorded by a planter about half a mile away and by the District

Agent about a mile and a half away, so that the swarming was clearly a vast concern.

The next night at about 6.55 a number of flying ants appeared round my lamp, and though we had nothing approaching the swarm of the day before, yet there were far more than there had ever been on any other previous day.

Some of the less conspicuous insects have turned out to be interesting. The Apterygota[1] (silver-fish and spring-tails) constitute the most primitive group of insects. Not only have these animals no wings, but there is no conclusive evidence that their ancestors ever had them. They may possibly be the representatives of the insects before wings were acquired in the course of evolution. I found only four species altogether, but all these were new to science, and one was so different from any known ones that a new genus had to be formed for it.

The Psoptera[1] (book-lice) again were peculiar, one of them requiring a new species and another a new genus. It is hard to say, in the case of the silver-fish, spring-tails and book-lice, whether the evolution of the new species and genera has occurred within the New Hebrides, or whether the same species occur on other Pacific islands where no one has collected them.

*Breeding Seasons.*—I was anxious to find out whether animals had any special breeding seasons in such a peculiarly constant climate as that of the New Hebrides, or whether they simply bred all the year round.

In Fig. 14 the temperature (1927) and length of day of Espiritu Santo are compared with those of

[1] For references, see Appendix.

Oxford. The comparative constancy of the New Hebridean climate as regards these two factors strikes the eye at once. In the matter of rainfall, there is less constancy, as the figures given in Table 6 show ; but the reader will notice that every month has much more rain than the wettest month at Oxford. Although one part of the year has less rain than the other, there is no part that can properly be called a dry season.

A word must first be said about the causation of breeding seasons in vertebrates in general. There is hardly a phenomenon so much a matter of common knowledge about which we are so ignorant. We could only be said to understand the causation of breeding seasons in a given animal if we knew what environmental change it is that determines its breeding season in nature, and if we could cause it to breed and stop breeding at will in the laboratory by making that environmental change artificially. This has not been done for any vertebrate.

Temperature, rainfall, amount of light and nutrition seem the most likely controlling variables. We all know that many animals tend to start breeding early when the warm days of spring come early. As regards rainfall, it has been found that birds may stop breeding for more than a year during an exceptional drought.[1] Length of day has been shown to have an important influence on the assumption and retention of breeding condition in

[1] Berney, F. L., *Mem. Queensland Mus.*, Vol. 9, Pt. 2, 1928.

male birds, but subsequent experiments have shown that it is the greater amount of exercise taken when the days are long, and not the amount of light itself, that is the controlling factor.[1] Nutrition also has an effect on ewes, which can be made to breed earlier by providing them with rich pastures.

It seemed unlikely that the small seasonal changes of the New Hebridean climate would be sufficient to cause definite breeding seasons. To investigate the matter I chose for study a mammal (the fruit-bat Pteropus geddiei), a bird (Zosterops vatensis), and a lizard (Lygosoma kordoanum). I divided the year into six periods of two months each, and determined the breeding condition of the species named in each of these periods.

In the case of the fruit-bat I regarded all specimens whose head and body measured 20 cm. or more as adult. I examined an average of nine adult males and nine adult females in each of the two-monthly periods. Males I classified as "fecund" when there were many sperms in the epididymes,[2] and as "non-fecund" when there were hardly any or none. Females are "pregnant" or "non-pregnant".

The graph (Fig. 21) shows what percentage of males is fecund and what percentage of females is pregnant at each period of the year. It will be noticed

[1] Rowan, W., *Nature*, 7 July, 1928, p. 11.

[2] The epididymis is the mass of minute coiled tubes, attached to the testis, in which the ripe sperms are stored.

FIG. 21. GRAPH SHOWING THE REPRODUCTIVE CONDITION OF ADULT PTEROPUS GEDDIEI (FRUIT-BAT) THROUGHOUT THE YEAR.

that there is a very well-marked breeding season, despite the uniformity of the climatic conditions. Roughly two-thirds of the females are pregnant from January—February till July, after which month no more embryos are found. I have kept July separate from August, since July is evidently the month in which the young are born. Apparently nearly all the females are fertilized in January–February, and have only one pregnancy (invariably of one embryo only) each year ; for the diameter of the pregnant womb (depending on the degree of development of the embryo) increases regularly, as the following averages show :—

| | |
|---|---|
| January–February . | 5·6 mm. |
| March–April . | 9·3 mm. |
| May–June . . | 35 mm. |
| July . . . | 52 mm. |

There is a cycle in the male also, as the graph shows, for the proportion of adult males that are fecund is lower from July to October than during the rest of the year. The average weight of the testes also varies regularly as follows :—

| | |
|---|---|
| January–February . | 2·88 gm. |
| March–April . . | 2·46 gm. |
| May–June . . | 1·63 gm. |
| July–August . . | 0·61 gm. |
| September–October . | 1·14 gm. |
| November–December. | 2·35 gm. |

Nevertheless it is evident that the male does *not* control the breeding season ; for some males are

fecund at all times during the year. It seems certain that the females do not come into the condition of "heat" after bearing young in July, until about the beginning of the next year. What controls their cycle I do not know. It is not impossible that a nutritive factor might be concerned. The onset of "heat" might be induced by the ripening of a certain fruit, the time of which depended on a small climatic change. But this is pure speculation.

Mr. J. R. Groome has worked out my Zosterops (bird) material. (Fig. 18.) The breeding condition of the females could not be satisfactorily determined, owing to the fact that only two specimens were found with an egg in the oviduct.[1] No very marked changes occurred in the weight of the ovary, the diameter of the largest growing egg in the ovary, or the diameter of the oviduct, but all these were at their lowest in March-April and at their highest in September-October. As regards the males, a distinct breeding season was shown to exist. Specimens of 18 gm. and more were regarded as adult. The material consisted of an average of seventeen adult males in each of the two-monthly periods. In January-February roughly half the adult males were fecund. In March-April and May-June none were fecund. The percentage rose sharply thereafter and in September-October 66% werefecund. Latern in the year the percentage fell. In the same way the average weight of the testes rose from 12 milligrams in March-April to 194 milligrams in September-October.

In the lizard, Lygosoma kordoanum, I took all specimens of 1·25 gm. and more as adult. An average of 36 adult

[1] The oviduct is the tube down which the egg passes to the exterior.

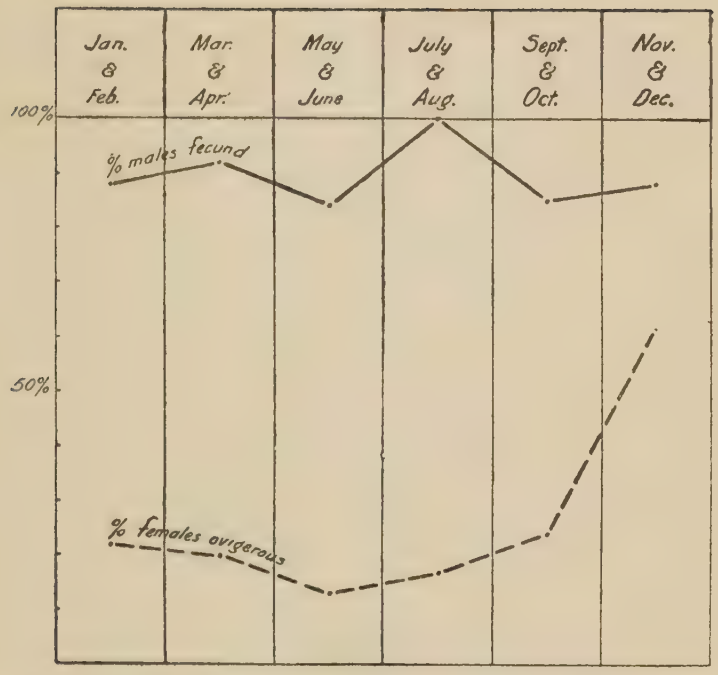



FIG. 22. GRAPH SHOWING THE REPRODUCTIVE CONDITION OF ADULT LYGOSOMA KORDOANUM (LIZARD) THROUGHOUT THE YEAR.

males and 45 adult females were examined in each period of two months. Fig. 22 shows the result of the investigation. It will be noticed that all the year round over 80% of the adult males are fecund. The breeding condition of the females was determined by examining the oviducts. The specimen was classified as " ovigerous " if it had an egg in each oviduct. (In no case was a specimen caught with an egg in one oviduct and not in the other, nor with more than one egg in one oviduct.) It will be noticed that at least 13% of the females are ovigerous throughout the year, and that in November-December the figure rises to 62%. Thus, although there is no non-breeding season, yet breeding is far more active in November and December than at other times. The graph shows quite conclusively that it is a change in the female and not in the male that determines the particularly active breeding in November-December ; for there are plenty of fecund males throughout the year.

The reader who is interested should try to find some correlation between reproduction and climate from the facts given. The only general conclusions I can draw are that all three species have some periodicity in reproduction despite the small amount of seasonal change in climate ; that in the fruit-bat and the lizard it is the female that controls the breeding season or season of maximum reproduction ; and that the greatest amount of conception takes place, in all three species, when the days are getting longer or very soon afterwards. But what the environmental conditions are that *actually* determine the periodicity, experiment alone can decide.

## Chapter V

# INTERSEXUAL PIGS

IN many of the lower animals the sexes are combined in every individual. We do not find male and female earthworms or male and female snails. In these forms every individual is an hermaphrodite, functioning both as male and female. Among vertebrates normal hermaphroditism is on the contrary very rare, being confined to the hag-fish (Myxine), the sea-bass (Serranus), and a very few other fishes. But among those vertebrates in which the sexes are normally separate, an individual is occasionally found with abnormal reproductive organs comprising both male and female elements. In mammals the best known example is the " free-martin " or sexually-abnormal heifer. In European breeds of pigs and goats intersexes also occur from time to time. Farmers call pigs of this type " wilgils " or " wildews ". Their anatomy has been studied in detail by Dr. Crew [1] and myself [2] among others. The gonads [3] are usually degenerate testes without sperms, but sometimes there

[1] Crew, F. A. E., (1923), *Proc. Roy. Soc.*, series B, vol. 95, p. 90.

[2] (1925) *Brit. Journ. Exp. Biol.*, vol. 2, p. 247.

[3] The term " gonad " means the part of the body which produces sperms or eggs in the normal individual; that is, the testis in the male and the ovary in the female.

is a little patch of ovarian tissue on one or both of the testes, or one of the two gonads may be an ovary. The external organs generally approximate to the female type, though the clitoris (which in the normal female is the very small representative of the penis of the male, not showing externally) is usually enlarged so as to distort the vulva (the external opening of the female system) to some extent. As regards the internal organs other than gonads, there is usually a more or less well-developed male system, as well as a more or less well-developed female system. Thus some rudiments at least can often be found of all the following organs :—

*Male organs.*

Epididymes (the organs which serve to store the sperms in the normal male).

Vasa deferentia (the tubes which conduct the sperms from the epididymes to the exterior).

Vesiculae seminales } (Glands which add a secretion to
Bulbo-urethral glands } the semen.)

*Female organs.*

Oviducts (tubes which carry the eggs from the ovary to the womb).

Womb.

Vagina (the part which in a normal female receives the penis of the male in copulation).

So far I have dealt only with the rare cases of intersexuality in European pigs. Little did anyone think that hidden away in a little group of islands in the Pacific there were thousands of intersexes of a type quite distinct from the European ones and vastly

more abundant. Two anthropologists had made short references to the intersex pig in dealing with the sociology of the New Hebrides, but no biologist had chanced to come across these references.[1] I was therefore amazed to find, on arrival in the northerly islands of the group, that there were intersex pigs in every little village. I have dealt in Chapter II with the great importance of these animals in the social life of the people, particularly in the matter of chief-making. In this chapter I confine myself to their biological aspect.

I had some difficulty in getting specimens for dissection, as the natives were very loath to sell. It was tantalizing to be surrounded by these (to me) intensely interesting monstrosities, and yet to be unable to cut them up and resolve the problems of their internal anatomy. However, the news soon spread that a peculiar white man had arrived who gave vast sums of silver for the *ndrē*, and at last natives began to bring me ones which had broken tusks (a great blemish in their eyes), or which had been half-killed by dogs. Altogether I dissected nine, and made notes on the external genitalia of ninety-one.

The thing that strikes one most forcibly about the *ndrē* is its remarkable abundance. Nowhere in the world are mammalian intersexes so abundant. In

[1] Codrington, R. H., *The Melanesians* (Oxford, Clarendon Press, 1891), pp. 57 and 80.
Rivers, W. H. R., *The History of Melanesian Society* (Camb. Univ. Press, 1914), vol. i, pp. 38, 80, 98, and 107.

England one may at long intervals get an occasional intersex pig from a bacon factory which kills perhaps a thousand pigs a week and is on the look-out for them. In Espiritu Santo and Gaua they occur in every little native village. *I once saw no fewer than* 125 *intersexes in one single day at Hog Harbour*, when an exchange of many young intersexes for a few old ones brought from another island was taking place. I tried to collect figures to indicate their abundance relative to normal pigs, but soon found it impossible, as it would have been necessary to get the co-operation of all the natives who owned pigs in several villages. I hazard the estimate that there are between ten and twenty intersexes per hundred normal males in Sakau. (As was mentioned in the second chapter, most of the female pigs are killed young.)

The following is a list of the islands on which intersexes are known to occur. In brackets after each island is given the name that the intersex pig is called there. Mota (*rawē*) ; Gaua (*rau* or *rolas*) ; Espiritu Santo (*ndrē* or *nërē* in Sakau, *ra* or *ravē* in the rest of the island) ; Ambrim (*teret*) ; Tongoa[1] (*pulpul*). They also occur in Merelava[2] and Merig,[2] but in these islands they were absent until sows which were known to produce them were imported for that purpose. In Malekula, Efate and the islands south of Efate, intersex pigs do not occur.

[1] North of Efate.

[2] These are very small islands in the Banks group.

## INTERSEXUAL PIGS

In their anatomy the intersex pigs of the New Hebrides differ fundamentally from those of European breeds in the absence of any rudiment of oviduct, womb and vagina. The male internal organs are sometimes well, sometimes poorly developed. The testes are always more or less degenerate and generally wholly so, with complete absence of sperms.[1] Even if sperms were present (there appeared to be a few abnormal sperms in the testes of one of the nine individuals), the intersex could never reproduce, for the approximation of the copulatory organ to the male condition is never sufficiently close. There is no ovarian tissue. The external organs vary from almost exactly the female condition to something approaching the male. The natives of Sakau classify the *ndrē* into the following seven groups according to the external genitalia. This grouping is sufficiently precise to be used in a scientific account of the abnormality. The significance of the translation of each name will be explained later.

(1) *ndrē rasa* = feminine intersex.
(2) *ndrē rünedh* = sprouting coconut intersex.
(3) *ndrē narsögh* = sewn-up intersex.
(4) *ndrē ghara* = fruit-bat intersex.
(5) *ndrē nau* = rat intersex.
(6) *ndrē ghor-ghor* = hidden intersex.
(7) *ndrē selet* = worm intersex.

[1] The cells, called "interstitial cells," which produce the male *hormone* (see later in this chapter), are usually abundant.

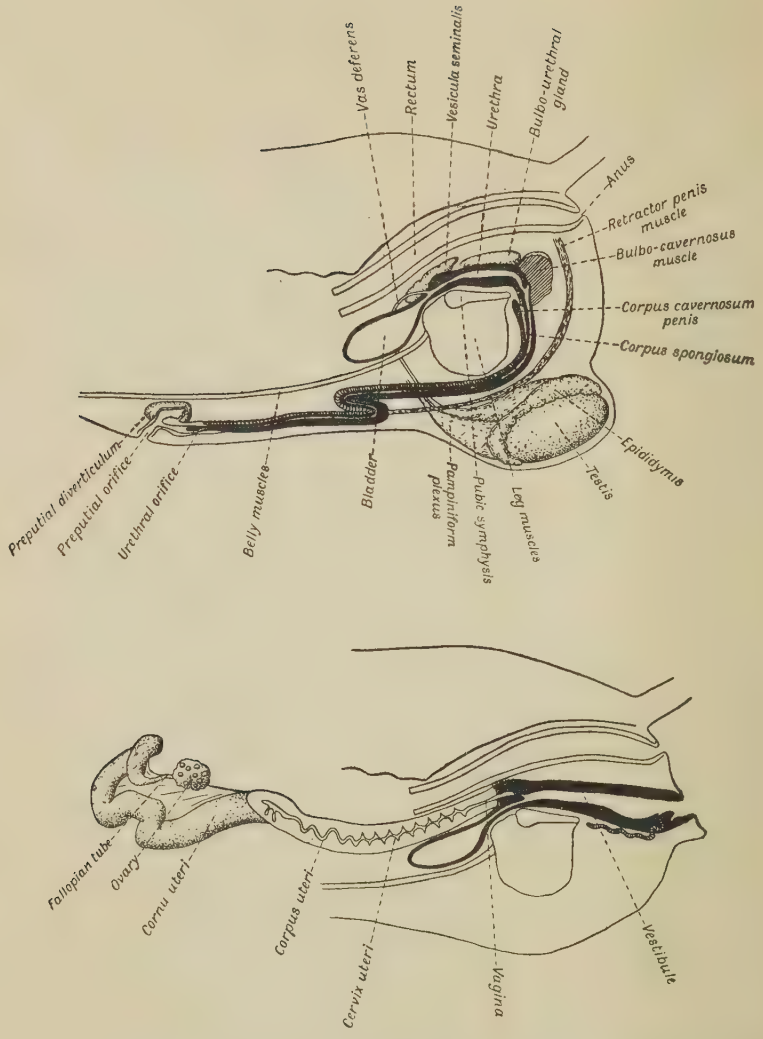



FIG. 23. DIAGRAM OF THE REPRODUCTIVE ORGANS OF A MALE PIG (above) AND OF A FEMALE PIG.

*By kind permission of the Cambridge University Press.*

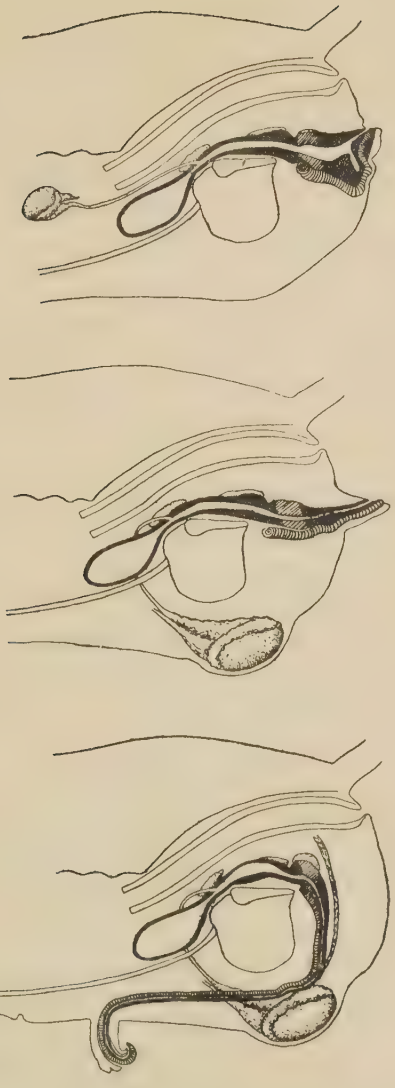


Fig. 24. Diagrams of the Reproductive Organs of Intersex Pigs. *Rasa* (above), *rünedh* (middle), and *selet* (below).

*By kind permission of the Cambridge University Press.*

[*page* 121

These grades run into each other, and often it is not possible to decide with certainty to which grade a pig should be assigned.

Fig. 23 shows the anatomy of a normal male and female and Fig. 24 that of three types of intersex (*selet*, *rünedh* and *rasa*). The figures, which are semi-diagrammatic, represent vertical longitudinal sections through the posterior end of the body, seen from the left side.

The same conventions having been used throughout these figures, the name of any unlabelled part can be determined by referring to the figure of the normal male, the parts of which are labelled. The corpus cavernosum (the main erectile part of the copulatory organ) stands out in each picture from being marked with curved lines, while the urethra (the tube which in the normal male carries both urine and sperms to the exterior) is solid black. Sexual organs of the right side (e.g. right testis and right vesicula seminalis) are represented as well as the median organs. It should be noticed that in the normal female pig there is a projection at the lower end of the urinogenital aperture called the ventral labial commissure. [1]

It is simplest to start by describing the *ndrē rasa* (Fig. 24), in which the external appearance is practically that of a normal female, except for the presence, in adults, of tusks. The testes, being situated inside the abdomen, are not visible, and the vulva is often hardly distinguishable from that of a female externally, though the corpus cavernosum is usually enlarged and the urinogenital aperture thus reduced to a slit. In its enlargement the corpus cavernosum often pushes the ventral labial commissure upwards and outwards. The terminal part of the urethra is distinguished from the corresponding part of the normal female by the presence of the bulbo-cavernosus muscle, which helps in the normal male to expel the sperms during copulation.

[1] Not labelled in the diagram.

It is easy to derive the *ndrē rünedh* (Fig. 24) from this condition. The testes are typically descended into a more or less well-formed scrotum (as the bag of skin which holds the testes of a male is called), and the corpus cavernosum has enlarged so as to push the ventral labial commissure a considerable distance outwards. The corpus cavernosum projects somewhat to the exterior, and the urinogenital aperture is very small. The name *rünedh* is derived from the resemblance of the projection formed by the corpus cavernosum and labial commissure to the sprout of a germinating coconut.

In the remaining grades the corpus cavernosum is turned downwards as in the male and enlarged to different degrees. In its enlargement it carries the ventral labial commissure with it. The projection, consisting of the ventral labial commissure, the corpus cavernosum and the terminal part of the urethra, may be situated anywhere from just below its position in the *ndrē rünedh* to close behind the position of the urinogenital aperture in the male (i.e. in the middle of the belly). In these intersexes the testes are usually descended into a scrotum.

When the projection is situated in the scrotal region, it commonly happens that the external urethral orifice is occluded, so that the ejection of urine is impossible and death would soon ensue. In these cases the natives make a small incision through the skin into the urethra on the body-wall just above the base of the projection. These intersexes are called *ndrē narsögh* from their being "sewn-up".

When the projection is long and situated near the anterior end of the scrotal region, the term "*ghara*" is applied, from the close resemblance of the external genitalia to those of a male fruit-bat.

When the corpus cavernosum has enlarged to about the same extent, but has done more of its enlargement inside the body, the projection is shorter but further forward; and the name "*nau*" is applied from the resemblance to the condition in the male rat.

In the "*ndrē ghor-ghor*" the externals are similar to those of the *ndrē nau*, but the projection is still further forward and hidden from view when the animal is seen from behind. The name is derived from the fact that the projection is hidden.

The *ndrē selet* (Fig. 24) is similar to the *ndrē ghor-ghor*, but the further enlargement of the corpus cavernosum has resulted in its extrusion from the end of the projection in worm-like form. The word "*selet*" means a worm.

The gross and microscopic anatomy of eight of the specimens is given in tabular form in the appendix to my paper in the *British Journal of Experimental Biology*.[1]

*Genetics.*—The natives of Sakau maintain that a female pig which has produced one or more *ndrē* usually produces one or more in every farrow, and further that females born in the same farrow as a *ndrē* are themselves *ndrē*-producers. The natives of Gaua call an intersex-producing female "*wurupkwaaval*", while one which does not produce intersexes is called "*wurupowor*". Female pigs which are born in the same farrow as intersexes are called "*wurupkwaaval*" from birth onwards; they are confidently expected to produce intersexes later on, and cost twice as much as "*wurupowor*". The male parent is not supposed to have any connexion with the production of intersexes, but since males and females run loose together and no controlled matings are made, the natives cannot be supposed to know much about the influence, if any, of the male parent.

[1] 1928, vol. vi, p. 56.

I brought home alive two intersexes and the brother and sister of one of them. Dr. Crew is keeping these at the Animal Breeding Research Department of Edinburgh University, and the two normals will be bred from when they are old enough.

The reader with no knowledge of genetics must skip the next paragraph.

The natives' story of the genetics of the abnormality nearly fits in with the assumption that it is caused by a sex-linked factor, intersexes being males carrying this factor. Intersex-producing females would be heterozygous for the factor. Females homozygous for the factor can never occur in nature, for they could only arise by the mating of two pigs both of which carried it ; and this could never be the case without artificial insemination, for the would-be males which carry the factor are of course intersexes, whose copulatory organs are never sufficiently well developed to function as such. Though it is rare for sperms to be present in the testes of intersexes, still it is possible that they may occur in one of the two that I have brought home ; in which case artificial insemination, using these sperms, should settle the chromosomal sex of the intersex.

Of the 86 intersexes from Espiritu Santo on whose external genitalia I made notes, 11 were *rasa*, 40 *rünedh*, 11 *narsogh*, 10 *ghara*, 5 *naü*, 8 *ghor-ghor*, and 1 *selet*. A most intelligent native of Gaua assured me that all the intersexes of Gaua have the projection close to the normal position of the female aperture, and my own observations confirmed this ; for the ones on which I made notes were a *rasa* and four

*rünedh*, and all the other intersexes I saw there were of these two grades. This seems a most significant fact in the genetics of intersexuality, for there is clearly an inherited tendency to certain grades of the abnormality.

*Physiology.*—Before one can appreciate the theories which have been brought forward as partial explanations of intersexuality, it is necessary to know something of the physiology of the development of these organs in the normal male and female.

In a normal developing embryo, there are two little pieces of tissue which will grow either into testes or into ovaries. Whether they grow into testes or ovaries depends on the sperm which fertilized the egg from which the embryo developed. Now some sperms contain a minute body called an " X-chromosome " and some do not. Eggs which are fertilized by sperms containing an " X-chromosome " grow into embryos having ovaries ; those fertilized by sperms containing no " X-chromosome " grow into embryos having testes. In other words, it is the presence or absence of an " X-chromosome " derived from the sperm that determines whether the two little pieces of undifferentiated tissue referred to at the beginning of this paragraph shall grow into ovaries or testes. But the " X-chromosome " has no direct effect on the other reproductive organs, such as womb, vagina and breasts in the female and vasa deferentia and penis in the male. What determines the sex of the embryo as far as these " accessory " organs of reproduction are concerned ?

It is essential for the reader to grasp that there is in *every* embryo a little rod that *can* grow into a penis and *can* grow into a clitoris, and there are rudiments which *can* grow into

epididymes and vasa deferentia as well as rudiments which *can* grow into oviducts, womb and vagina, and again there are breasts which *can* remain small, in the male condition, and *can* grow large to form milk-secreting glands. *In other words, every embryo is a potential intersex, with the ability to grow up with all these organs of both sexes.*

It is due to " hormones " that every embryo does not in fact grow up to be an intersex. Hormones are substances which are poured into the blood by various glands and which, dissolving and getting carried to all parts of the body in the blood stream, control the growth or actions of various parts of the body, often far distant from their seat of origin. It is hormones controlling growth that interest us here, *for the testes secrete a hormone which encourages the development of the male accessory organs, while the ovaries secrete a hormone which encourages the growth of the female organs.* It is for this reason that an embryo which has testes normally grows to be a thorough-going male, and an embryo which has ovaries grows to be a thorough-going female. The rudiments of the accessory reproductive organs of the inappropriate sex receive no encouragement from hormones and therefore remain rudimentary.

The foregoing may be summarized by saying that whether testes or ovaries grow depends on whether there is an " X-chromosome " brought in by the sperm ; and whether the male or the female set of accessory organs grows depends on whether there are testes or ovaries.

The reader who has mastered this is in a position to follow the hypotheses which have been put forward to explain intersexes. Personally I regard intersexes in goats and European breeds of pigs as derived from embryos in which, for some as yet unexplained reason, both testicular and ovarian tissue was present, so that both testicular and ovarian

hormones were produced and thus the various organs of both sexes were stimulated to develop, at least to some degree. The ovarian tissue, having stimulated the female organs to development, seems usually to disappear or at least to become reduced, so that it is not commonly found in adult intersexes.

Dr. Crew's theory is different. He regards the intersex simply as a male whose testes have started to pour out their hormone too late. He postulates that the various organs require to be stimulated to development by the appropriate hormone *at a certain definite age in the life of the animal*, and that if this age is passed by without the hormone being poured out, then no amount of hormone later on will cause them to develop fully. He also supposes that the testicular hormone not only stimulates the development of the male organs but also prevents the development of the female organs, and that if it is poured out too late the female organs will develop at least to some extent.

It is the latter part of his theory with which I am inclined to disagree. If one castrates (i.e. removes the testes from) a young male pig, the male organs stop growing because there is no hormone to encourage their growth ; *but the female organs do not grow.* Not only is there no evidence that the testicular hormone prevents the growth of the female organs, but there is positive evidence that it does not. Thus Dr. Crew's hypothesis explains the poor development of the male organs in intersexes, *but does not explain the development of their female organs.*

Although I am convinced that Dr. Crew's hypothesis will not account for intersexes of European breeds, which nearly always have some remnants at least of womb and vagina and often have them quite well developed, yet I believe that the first part of his theory *does* account for these New Hebridean intersexes, which have no female internal organs.

Fig. 25. Lower jaws of tusked pigs. The natives of Gaua designated the jaw represented in the upper figure as that of a male, the other as that of an intersex.

(*Photos by Mr. W. Chesterman.*)

*By kind permission of the Cambridge University Press.*

[*To face p.* 128.

One has only to assume that the typical female vulva will differentiate in the absence of any ovarian hormone (and there is no evidence at all that it will not), and that the end of the urethra thus normally forms itself into a vulva unless the testis-hormone is present to alter its development by stimulating the growth of the corpus cavernosum. The *ndrē rasa* is then simply a male in which the testis has developed very late, after the vulva has been formed; the corpus cavernosum may enlarge a little and slightly modify the vulva, but essentially the externals remain female. Once the vulva had been properly formed, no amount of testicular hormone poured out too late can cause the corpus cavernosum to enlarge so as to push the end of the urethra and the ventral labial commissure round towards the belly of the animal. But if the testes are formed a little less late, the corpus cavernosum starts to enlarge a little before the vulva is complete, and a *ndrē rünedh* results. Earlier development of the testis results in the *ghara* or *nau*; earlier still in the *ghor-ghor* or *selet*. But even in the *selet* the ventral labial commissure can be detected. In the normal male the testes are formed before the vulva is fashioned at all, and the early enlargement of the corpus cavernosum results in the end of the urethra being carried right round to the characteristic male position on the belly. Uterus and vagina are not formed, simply because there is never any ovarian tissue.

*Tusks.*—All adult intersexes possess tusks similar to those of boars, and this serves immediately to distinguish an adult *ndrē rasa* from a normal female without dissection, which is not always possible in the young.

The natives knock out the upper canines of males and intersexes in order to allow the lower canines

to grow indefinitely. Their growth being circular, at the age of perhaps eight years the tip of the tusk often re-enters the bone of the lower jaw close to its own root. Sometimes it passes so far out as to miss the lower jaw, and considerably more than a complete circle of tusk may then be formed. These tusks are shown in Figs. 16 and 25.

The natives of Gaua (but not of Espiritu Santo) unhesitatingly designate one tusk as that of an intersex and another as that of a boar, but I have not been able to find out their criteria of distinction. They seem to judge by the colour of the tusk and the degree to which it has been worn down. Certainly the dentine of the tusks of some intersexes is partly yellowish or brownish, but this is by no means invariable.

## Chapter VI

## STEAMING HILL LAKE

IN his great work *The Melanesians*,[1] Dr. R. H. Codrington says (p. 17) :—"The Tas in the middle of Santa Maria [Gaua] in the Banks Ialands is the only lake of considerable size in Melanesia. It is about five miles long, occupying the hollow of an ancient crater, into which the steaming hill Garat has been intruded ; the waters pour out in a magnificent waterfall . . . the Tas of Santa Maria will surely reward its first scientific visitor." It has been my fortune to be its first scientific visitor.

Mr. (now Sir) Douglas Mawson mentions the lake in his paper on the geology of the New Hebrides,[2] but evidently he did not visit it. Several missionaries and Mr. G. R. Salisbury have seen the lake, but there has not previously been an adequate map of it. In the Admiralty Chart and the map of the French Ministère des Colonies it is represented (obviously from report only) in quite the wrong position, of quite the wrong shape, and far too small.

During my first visit to the New Hebrides I was brought to the island of Gaua on the steam yacht

[1] See footnote to p. 17.
[2] *Proc. Linn. Soc., N.S.W.*, vol. xxx.

"Southern Cross" by courtesy of the Melanesian Mission. I made two expeditions to the Lake, the first in company with the Rev. R. E. Tempest and Mr. T. T. Barnard. Both these visits were for an hour or so only, as we had not facilities for camping there; further, we had not sufficient instruments for a proper scientific study of the Lake nor a boat in which to explore it. Nevertheless, the few animals I took in a hand-net encouraged the belief that the fauna would be interesting. The isolation of this great Lake from any other large expanse of fresh water could hardly have failed to cause it to be tenanted by an interesting group of creatures. What animals could have found their way there? How had they become modified as a result of their isolation? I was determined to find out on my second visit to the islands.

This time I lacked nothing. In addition to camping outfit I had a collapsible boat, boulting-silk hand-nets, large and small plankton-nets,[1] a dredge, fishing-tackle, pipettes, enamelled basins, jars and tubes for specimens, alcohol, formalin, apparatus for determining the degree of alkalinity or acidity of the water, a water-sample bottle, a light sounding-apparatus specially made by my brother, an ordinary thermometer, a minimum thermometer, a reversing thermometer to take temperatures at all depths in the Lake, a prismatic compass and an aneroid barometer.

[1] The term "plankton" denotes all the small floating organisms in a large expanse of water.

Fig. 26. The collapsible boat on Steaming Hill Lake.
*(Photo by Mr. J. de H. Morel.)*

[*To face p.* 132.

It seemed at first that my excellent equipment was going to be wasted owing to my inability to get to the island of Gaua at all, for the inter-island steamer does not call there and the "Southern Cross" was not in the group. I asked the representatives of Messrs. Burns Philp and Co. (the steamship owners) at Vila to get their boat to stop at Gaua to put me down there on its way from Vila to the Santa Cruz group, north of the New Hebrides. They were most agreeable, but said that the Government would never allow it, since the boat was "cleared" by the Customs at Vila and was not allowed to call anywhere until it entered the Santa Cruz group. Undismayed, I called upon the British Resident Commissioner, who said he would give the necessary leave if the French Resident Commissioner would do the same. The French Resident Commissioner was equally obliging, and everything seemed hopeful. Messrs. Burns Philp gave instructions that their boat should go about 20 miles out of its course and put us down on the N.E. coast of Gaua.

Our luck was out. As we neared Gaua, an easterly swell became reinforced by a strongish wind from the same direction, making it very dangerous for the steamer to heave to in the open sea and put us ashore in whale-boats. To add to the difficulty, the tide was low and the reef dried off. Under the circumstances the Captain was undoubtedly right in refusing to put us ashore, and we were carried right out of the New

Hebrides into the Santa Cruz group. I shall not forget my feelings when I saw the village that had been my home four and a half years before, and which was to be my base for the exploration of the Lake, and was carried on past it to a part of the world to which I had no anxiety to go.

When we got back to the New Hebrides, we pitched our tent once more at Hog Harbour and hoped that some means of getting to Gaua would turn up unexpectedly. A planter called in at Hog Harbour in his cutter one day, and we besought him to take us to Gaua. He told us he was going south, but would call back in a day or two to bring us there. We made lists and packed everything up in readiness, and then started to wait, never going more than a few hundred yards away lest the planter should return and go away without us. We waited in this way for nearly a fortnight, every day seeming more exasperating than the last. At last he came—but refused to take us.

Months later our chance came. The inter-island boat came in to Hog Harbour. She was bound for Vanua Lava, an island to the north of Gaua. We felt that if we could get to Vanua Lava we could somehow manage to get from there to Gaua. The main difficulty now was how to get *away* from Gaua. Here Mr. T. O. Thomas came to the rescue, by most generously guaranteeing to send his cutter for us if we had not returned by some other means by a certain day.

Our party consisted of my wife, Mr. J. de H. Morel and myself. On arrival at Vanua Lava we got a Japanese Trochus-fisher to agree to take us to Gaua in his little cutter.

The distance to be covered was only about 25 miles, so we started off quite light-heartedly a little after 9.30 a.m. despite the roughness of the water out to sea. When we got outside the protection of the land and headed southwards, we were dismayed to find that our little oil engine could do nothing with the sea and wind against us. For an hour we actually moved backwards, and the Jap pressed us to allow him to return. But at last a slight change in the direction of the wind enabled us to progress, and later we were able to hoist our sails and make tacks into the wind. The sea was mountainous. One moment we were on the crest of a great wave, and Vanua Lava was clearly visible aft and Gaua forward ; the next we were down in the trough with nothing visible but angry water on every hand. We were a miserable human cargo on the tiny deck of the little craft, a mass of limp, prostrate black and white bodies holding on as tight as sea-sickness would allow. At the end of each great tack we seemed as far from our objective as we had been at the end of the one before, and I began to think that we should have to give in to the inscrutable little Jap, who left his engine now and then and scrambled forward to ask if he should turn and run back before the wind to Vanua Lava.

It was seven o'clock, and of course dark, when we experienced the indescribable relief of passing in a few moments from the rough sea through the breach in the coral reef at Losolav, on the north coast of Gaua, into the dead calm of the water within.

We slept on board, and next day put all our belongings into two dinghies belonging to the Jap and rowed round the coast inside the reef to Nombur. There was no white person on the island, but we were most hospitably received by my old friends the people of Nombur, with whom I had stayed nearly five years before. My wife was a great source of interest, and the women insisted on feeling her all over so as to be certain of her sex.

I had been worried for some time with the thought that I would not be able to get porters to carry all our gear to the Lake. There is no village near the Lake, so nearly everything we were to eat had to be carried. In addition there was, of course, the collapsible boat, our camping gear and the scientific apparatus. I hit upon the following plan to get the people to carry for us.

I told one or two of the chief people that I would like to address everyone in the village after sundown ; but I did not tell them on what subject I proposed to speak. I wished to catch them unawares and appeal to their herd-instinct at a time of day at which people are very susceptible to suggestion. If I had at once begun to ask them to act as porters, the news would get

about and many would begin to invent excuses for refusing.

Soon after it was dark the people assembled, the men in one group and the women in another. I stood between them in the light of our lantern and made a speech in pidgin-English which was interpreted, sentence by sentence, by a man who stood beside me. After a few words of welcome I came to the point. "Before, me go along Lake; me catch 'im all small something. By-an'-by me take 'im all small something along England. All man 'e look, 'e speak 'e no look 'im before. By an'-by all 'e speak, 'you go along Gaua; you catch 'im some more all same.' Which way me take 'im calico house belong me, kai-kai belong me, all something belong me along Lake? Three white man here, 'e want stop seven days along Lake. 'e no savvy take 'im all something. Me want 'im all man, all woman, all picinniny 'e take 'im all something belong me along Lake. Two big fella 'e take 'im boat."

I looked round to judge the effect of my appeal. I could gather nothing from their faces in the lamp-light. A few murmured remarks, a few glances, and the decision was made. I looked to my interpreter, fearing the worst. *Everyone*, man, woman and child, would come to carry my things to the lake! I had suffered so much from delay in the islands that I had little hope when I asked when they would be prepared to start. Another mute referendum was

taken, and to my joy the interpreter announced that they would bring us and all our baggage to the Lake the next morning. My ruse had worked indeed! The total population of Nombur is 31. Next day, with a few recruits from a neighbouring village, we had nearly 30 porters.

Next morning (31st May, 1927) we started off at about 9.30, everyone including ourselves being laden. The women who had babies carried them, so they could not be described as very efficient porters from my point of view; but it was a great day for them, as they had never seen the Lake before. Our guides were determined to show us off to the other natives of the island as much as possible, so they brought us a very roundabout route, passing by several villages, and we did not arrive at the Lake until nearly two o'clock. (On my first visit we had walked there in $2\frac{3}{4}$ hours.) When we came over the lip of the crater and saw the great Lake lying below us, we all experienced a first-rate thrill.

We descended to the shore and found a few upright posts indicating where a native house had been before. Our carriers set to work to build on these foundations, while we boiled some tea. They made us a splendid shelter thatched with wild banana leaves in a surprisingly short time. We threw our light-weight tent over it and secured it with ropes, and thus always had a dry retreat despite the heavy rain.

We made an arrangement with our carriers that

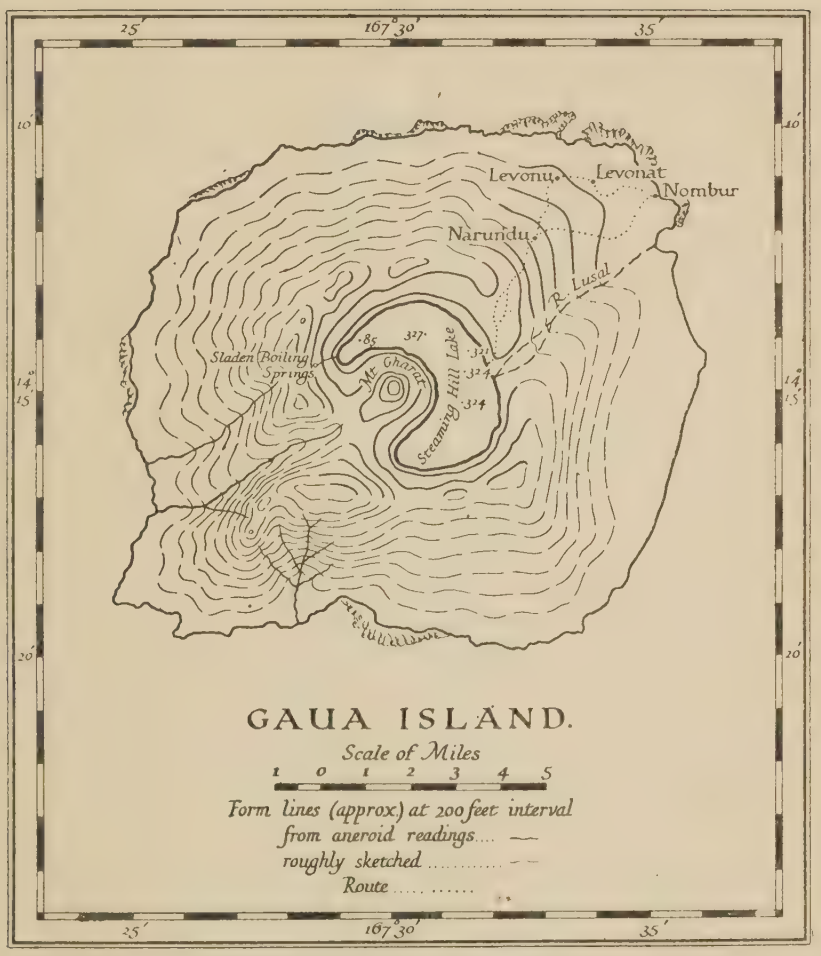



FIG. 27. MAP OF GAUA.

*By kind permission of the Royal Geographical Society.*

they should return on the seventh day to bring us back. After they had gone, we felt it rather strange that we were quite at their mercy. If they did not return on the agreed day, we should not be able to live at the Lake for more than a few days on account of lack of food ; nor could we find our way back to the coast. White people cannot find their way among the maze-like native paths, even when provided with a compass. One scarcely ever gets a view of the surrounding country, owing to the thick forest which hems one in on every side. We therefore put aside some of our store of food, and divided the rest into rations for the seven days. My wife, who was in charge of the camp arrangements and also helped with the geographical and zoological work, is the only white woman who has seen the Lake.

Fig. 27 represents the island of Gaua. The Lake, the surrounding hills and the track from Nombur and back are from my own observations. We measured a base nearly three-quarters of a mile long along the shore of the Lake northwards from near the outflow of the River Lusal, and mapped the Lake and surrounding hills by bearings from the ends of this line. The course of the River Lusal is from native report only. The remainder of the island is from the Admiralty Chart. The form-lines, which are 100 feet apart, are continuous where due to my observations and broken where sketched from the Admiralty Chart. The map was drawn from this material by my brother,

Mr. S. J. Baker, and redrawn for publication by the draughtsmen of the Royal Geographical Society. The Society has kindly given permission for it to be reproduced here.

The Lake is about 1,100 feet above sea-level. There seems to be little doubt that the basin of the Lake with its surrounding hills is the crater of an immense extinct volcano. Mt. Gharat is a secondary cone, its southern slopes being now in the solfatara stage, with steam and probably other gases ascending from them. The Lake has, curiously enough, no native name. They refer to it as " tas ", which simply means " sea ". Since it is inconvenient for it to be anonymous, I propose that it shall be called " Steaming Hill Lake ", from the steaming hill, Mt. Gharat.

Fig. 29 is a panorama, taken by Mr. Morel from the top of a large tree near our camp on the eastern shore. It is a reduction from four photographs pasted side by side. Mt. Gharat is plainly seen. Dense forest extends everywhere to the water's edge, the steaming southern slopes of Mt. Gharat being alone free from vegetation. Just outside the areas from which steam ascends, the vegetation consists of a low scrub and tree-ferns.

The sky was overcast and the temperature remarkably cool and unvarying during almost the whole of our week's stay by the Lake. On the 5th June, I recorded an air temperature of 22·5° C. (72·5° F.) at dawn, and only 23·1° C. (73·6° F.) at

one o'clock. This grey, almost dismal, deserted Lake had an eerie fascination for all three of us.

We explored the Lake by means of a "Ford" collapsible boat holding two persons. (Fig. 26.) The figures on the map give the depth in feet. The excellent light sounding apparatus made by my brother is probably accurate to within a few feet. It will be noticed that four of the soundings are almost exactly the same, and that the Lake is far deeper than any in England or Wales. It is evident that it is flat-bottomed, at a depth of approximately 325 feet.

By means of a series of six soundings at various distances between the sounding in 321 feet and the shore, I was able to show that the bottom slopes almost uniformly to this depth. Taking this fact into consideration, my brother was able to calculate approximations to the mean depth and volume. Table 7 gives this and other information about the Lake.

Table 7. Information about Steaming Hill Lake.

| Length (miles) | Depth (feet) | | Area (sq. miles). | Volume (millions of cubic feet). |
|---|---|---|---|---|
| | Max. | Mean. | | |
| 3·8 | 327 | 200 | 6·6 | 230,000 |

The temperature of the water at the surface in the middle of the Lake was always close to 25° C. (77° F.)

during our visit, though rather hotter (25·6° C. = 78·1° F.) in the N.W. basin, where the stream from the boiling springs (to be mentioned later) flows in, and much hotter (32·7° C. = 90·9° F.) in patches near Mt. Gharat. The subsoil of Mt. Gharat where we landed on it was uncomfortably hot to the fingers. I took a series of observations of the temperature of the water at various depths down to 303 feet in the middle of the Lake by means of a reversing thermometer, and found that there is not a uniform decrease in temperature with depth. This is shown graphically in Fig. 28. A body of water about 100 feet thick at about 25° C. rests upon about 200 feet of water at about 23° C., with a very small thickness of water at intermediate temperatures. The points on the graph are dependable, the temperature at each depth having been taken twice. In only one case was there a discrepancy of more than 0·1° C. between the two readings at the same depth.

The water is alkaline (pH. 8·5) and perfectly fresh. There is no truth in the statement made in *A Dictionary of the Language of Mota*[1] that the Lake is called "tas" (= sea, salt-water) because it is brackish. Dr. A. Voelcker, who has analysed my sample, finds that the total solids are only 0·449 gram per litre. (In sea water there are about 30 grams of salts per litre.) The salts are mainly those of calcium and magnesium, present probably as carbonates and

[1] By R. H. Codrington and J. Palmer (S.P.C.K., 1896), p. 204.

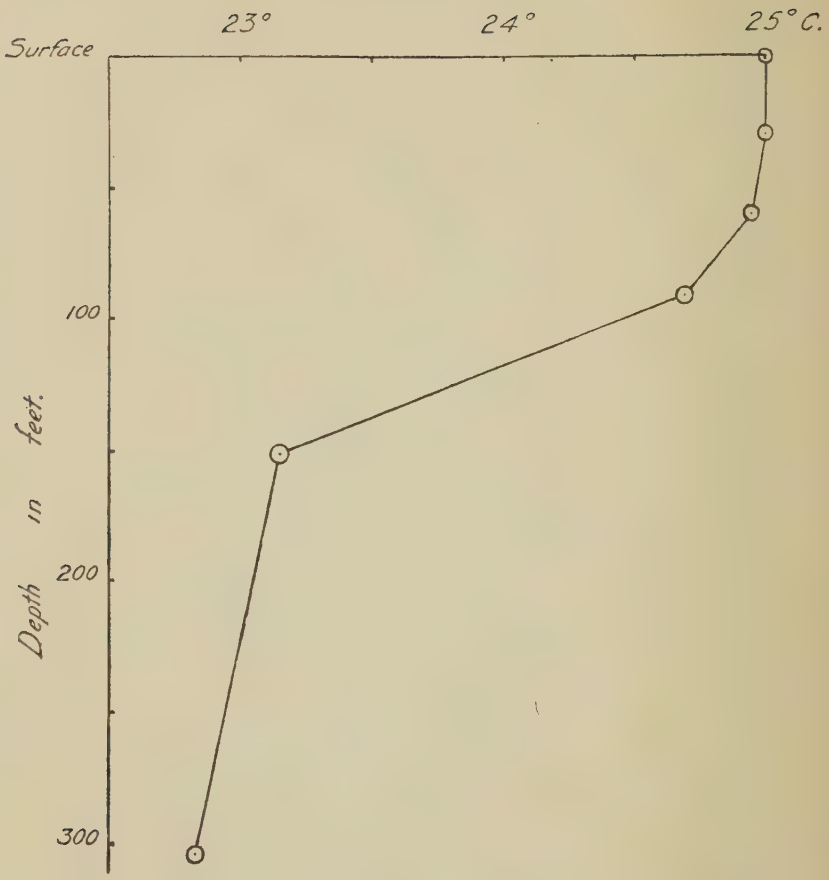



FIG. 28. GRAPH SHOWING THE TEMPERATURE OF THE LAKE AT VARIOUS DEPTHS.

*By kind permission of the Royal Geographical Society.*

sulphates, together with some sodium chloride. There is little potash, and nitrates are not present in any determinable amount (though presumably they would have been if my sample had been larger).

On the surrounding hills, to the north and again to the south of Mt. Gharat, we saw masses of steam ascending vertically from time to time. We had not time to find both these eruptive regions, but my wife and I sculled in the collapsible boat to the N.W. end of the Lake to explore the more northerly one. The ascending steam, which was clearly visible at a distance of four miles, was now invisible owing to the dense forest which everywhere surrounded us ; nor would the thick undergrowth allow us to follow up the hot stream to its source. We were beginning to think that we should never find our objective, when we were startled by an ejaculation behind us. A native had appeared, far more bewildered to see us than we to see him, though we had understood that no native lived within the crater.

Pidgin-English was, alas, of no avail, and I had to fall back upon gesture to explain that we wanted to be shown the source of the steam. I thought he had grasped the idea, for he led us off at a great pace up the side of the crater. At last he stopped at a shelter which he had made for himself, and we could not induce him to go on. He had supposed that we wanted to see where he lived ! More pantomime resulted in his starting off again, and we followed closely, only to be

disappointed when he came to a standstill at another wretched little shelter. The human body is scarcely adapted to a very precise representation of a geyser, but now I did my best. Crouching down to the ground, I suddenly sprang to my full height and extended my arms above my head (my topi unfortunately flying off into the hot stream), making a violent sizzling noise at the same time. He had grasped my meaning at last, and before long we were on the spot.

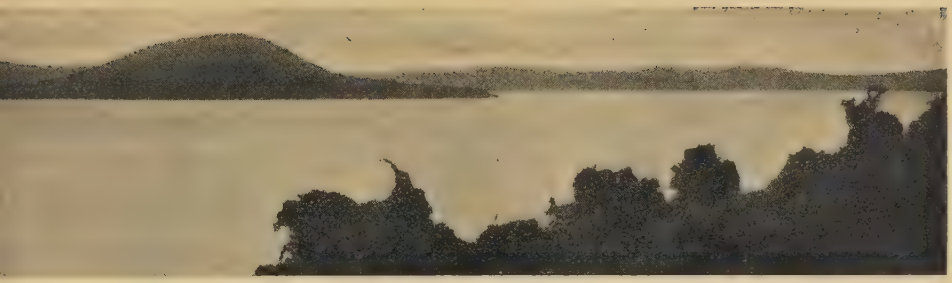
About half a dozen boiling springs are situated close together on the hillside within the crater which surrounds the Lake. One of these is shown in Fig. 30. I hesitate to describe these as geysers, although the great outbursts of steam seem to be periodic ; for during the short time we were able to stay there, no water was thrown far into the air. Each consists of a concavity in the hillside, the largest perhaps 60 ft. in diameter, with a pool of vigorously boiling water at the bottom, from which a cloud of condensing water-vapour ascends. The Rev. S. Ella is said by Sir Douglas Mawson to have seen a boiling spring on Gaua, and mention of hot pools and boiling mud is made by Codrington.[1] I do not know whether these are the springs in question. With the permission of the Trustees of the Percy Sladen Memorial Fund, I have given them the name of the " Sladen Boiling Springs ".

[1] Codrington, R. H., *The Melanesians* (Clarendon Press). p. 13.

Fig. 29. Pano

*Photos by Mr. J. de H. Morel, pasted together and*

Fig. 30. One of the Sladen Boiling Springs.
(*Photo by the Author.*)



of Steaming Hill Lake.

*tographed. By kind permission of the Royal Geographical Society.*

Fig. 34. A Coral less than five years old. A shilling placed on the specimen gives the size.

*(Photo by Mr. J. de H. Morel.)*

g. 33. Common Corals on the reef at Nombur. From left to right:—Montipora, Goniopora, Pocillopora, Acropora, Porites, Favites (above) and Goniastræa.

*(Photo by the Author.)*

*[To face pp. 146-7.*

Near the springs our guide showed us a deposit of what proved on analysis to be red ochre.

A small stream flows from the boiling springs to the Lake, having a temperature of about 32° C. (90° F.) half-way from its source. This waters the taro-garden of our guide, who is the only man living within the great crater. He ekes out his lonely living by placing his taro in the springs and thus boiling them. When the time came to depart, we gave him some safety-pins. These he unfastened and thrust through his ear.

The only exit for the water from the Lake is by the River Lusal, which arises on its eastern shore by two streams leaving the Lake only some twenty yards apart, but not joining (according to native report) for a considerable distance. I suppose the Lusal to be the same river as that which flows into the large bay about a mile south of Nombur. There is a large waterfall on its course, which can be seen from the sea.

Disregarding a few rocks near the outflow of the River Lusal, there is only one island in the Lake. This is close to the shore near its N.W. end, and only about thirty yards in diameter.

The following is a list of the animals which we collected in the Lake, as far as they have been worked out by specialists in the various groups. The ones which constitute new species or new varieties, or which differ in any way from the normal type of the species to which they belong, are in italics :—

| | |
|---|---|
| Protozoa . | *Centropyxis aculeata*, Stein, var. |
| Porifera . | *Ephydatia fortis*, Weltner, var. |
| Polychaeta . | Lycaestis quadraticeps, Gay. |
| Oligochaeta . | Pheretima speiseri, Michaelsen. |
| | Ocnerodrilus occidentalis, Eisen. |
| Cladocera . | Diaphanosoma sarsii, Richard. |
| Ostracoda . | *Stenocypris malcolmsoni* (Brady). |
| Copepoda . | Nitocra lacustris, Schmankevitch. |
| | Mesocyclops crassus, Fischer. |
| | M. obsoletus (Koch). |
| | Leptocyclops prasinus (Fischer). |
| | *Cryptocyclops bicolor*, G. O. Sars. |
| Decapoda . | Palaemon lar, Fabr. |
| Hemiptera . | *Limnogonus* sp. nov. |
| | Microvelia sp. |
| | *Enithares* sp. (? nov.). |
| | Anisops fieberi, Kirk. |
| | A. cleopatra, Dist. |
| Coleoptera . | *Colpodes* sp. (? nov.). |
| | Dineutes australis, F. |
| | *Bidessus* sp. (? nov.). |
| | *Hyphydrus* sp. (? nov.). |
| | Stignobia cauta, Wse. |
| Diptera . . | Chironomus sp. |
| Gastropoda . | Thiara leefii (Brot.). |
| | ? Potamopyrgus sp. |
| | *Physa* cf. *obtusa*, Morelet. |
| | P. sp. |
| Pisces . . | Anguilla megastoma, Kaup. |
| Aves . . | Nyroca australis, Eyton. |

The most obvious animals of the Lake are a duck, a large eel, some dragon-flies, a large prawn and a sponge. The presence of the duck, Nyroca australis, and the eel, Anguilla megastoma, is not hard to account for, for the duck has wings and the eel has a larva

which lives in the sea. The largest eel we secured in the Lake itself was 38 inches (97 cm.) long, and stout in proportion. The freshwater prawn, Palaemon lar, belongs to an essentially marine family, and seems to have no difficulty in getting from island to island. It is delicious to eat. The freshwater sponge, Ephydatia fortis, var., is an encrusting species of a green colour, which grows on rocks not far from the shore and is so abundant as almost to give the appearance of a coral reef. Freshwater sponges produce within them little balls of undifferentiated cells enclosed in hard resistant envelopes. These are called "gemmules", and are usually produced when the environment becomes likely to cause the death of the parent. They are set free by the decay of the parent and may be distributed by currents. When favourable conditions return, each gemmule develops into the adult form. These gemmules resemble eggs in their function, but differ in that they consist of many cells instead of one, and no fertilization takes place. It seems very probable that the ancestors of this sponge first came to the Lake in the form of gemmules in mud sticking to the feet of migrating ducks.

With the exception of a coot-like bird, of which we did not obtain a specimen, all the remaining animals in the Lake are small. The natives assured us that no fish occurs in the Lake except the eel, and certainly we never saw one. (Possibly another species of eel, Anguilla obscura, occurs in the Lake, for we

got a specimen, just over four feet long, near the Lake in the River Lusal.) Probably the waterfall on the River Lusal is the obstacle which prevents the various fishes (other than eels) which can live equally well in salt or fresh water from getting to the Lake.

Let us turn to those species which have evolved into slightly new forms as a result of their isolation. These stand out in the list from their being in italics. It is remarkable that this body of fresh water should contain so many varieties and species which occur (so far as is known) nowhere else in the world.

First there is the microscopic single-celled Centropyxis aculeata. In the specimens from the Lake the aperture of the shell, instead of being circular, is pear- or keyhole-shaped. Mr. R. Kirkpatrick considers that they constitute a new variety, for which he proposes the name of *cleidostoma*. The sponge again differs so much as to constitute a new variety. The specimens of the minute bivalved Crustacean Stenocypris malcolmsoni differ from the normal, not only in being somewhat larger but also in having the claws on the forked tail (caudal rami) stouter and more coarsely toothed. The specimens of another minute Crustacean, Cryptocyclops bicolor, differ from the normal in being smaller and in having the apical setae slightly longer. Of the eleven species of insects so far examined, no less than five appear to be new ; but details of the ways in which they differ from their nearest allies are not yet forthcoming. Unfortunately we did not get sufficient specimens of Physa cf. obtusa to make certain whether they should be regarded as forming a new variety.

It is a remarkable commentary on current views on evolution that no one could possibly suggest any way in which these differences from the normal could be of use to the Lake species. Perhaps the Lake was colonized in the first instance by a very small number of individuals of each of the peculiar species, who became the ancestors of all the multitude of individuals of those species in the Lake to-day. Then, if the few colonizing ancestors chanced to differ slightly from the normal in an inheritable character, the divergence of their descendants from the type of the species is explained. Another possibility is that the colonizing individuals were normal, but that a "spontaneous" variation,[1] neither beneficial nor harmful, turned up among some of the individuals and spread in the course of many generations throughout the whole of the individuals of that species inhabiting the Lake. This is not impossible in an enclosed area. A dog-breeder must not let his bitches come into contact with stray dogs from outside if he wishes to produce a new strain. The fence round his kennels corresponds to the vast ocean which surrounds this isolated Lake and makes it extremely unlikely that more individuals of the same species will arrive to check the evolution of a new race or variety.

By far the most abundant animal in the Lake is the minute

[1] When we call a variation "spontaneous", we mean simply that its ancestors did not show it and that we are ignorant of its causation.

Copepod Crustacean Mesocyclops crassus. It is essentially planktonic in habit, and swarms of it were brought up by the silk net when hauled behind the boat. We took a surface haul one overcast, moonless night, and it was as abundant as during the day. It was as abundant at the surface when the water was rough as when it was calm. One haul was taken when the sun was shining; again M. crassus was abundant. Altogether we took eight hauls with the fine-meshed plankton net. In seven of these M. crassus was the only Copepod; in the remaining one there were a very few M. obsoletus as well. It was abundant everywhere except in the N.W. corner. Possibly the hot stream, which flows in at the N.W. end, brings down some substance which acts unfavourably on it. The other three species of Copepods are confined to the vicinity of the shore, where we captured them in a hand-net.

M. crassus is a widely-distributed species, but it has never previously been found nearer to the New Hebrides than India. Presumably it will be found in the enormous intervening region when search is made for it. Mr. A. G. Lowndes, who examined my Copepods for me, has found the species, structurally identical in every way, at Cambridge; but there it has quite a different habitat, for it lives in small ponds and ditches.[1] Perhaps it cannot compete with the truly planktonic species in Europe, but fills the "biological vacuum" caused by the absence of such competitors in the Lake on Gaua.

It is perhaps worth noting that masses of this species crowded together in a bottle appear pink, though individual specimens are colourless and transparent.

When I was looking through water-weeds to find

[1] For reference to Mr. Lowndes' paper, see Appendix.

the animals living among them, I was astonished to find two little worms with large projections (parapodia) on each side of every segment of the body. Now the ordinary freshwater and terrestrial worms belong to the Class Oligochaeta, whose bodies are totally devoid of parapodia. It is the essentially marine group Polychaeta in which parapodia occur. Exceedingly few species of this large group have forsaken the sea to live in fresh water. Yet these specimens were undoubtedly Polychaetes, as was shown not only by their possessing parapodia, but also by the presence of eyes and an eversible pharynx, by the absence of a cocoon-secreting girdle or " clitellum ", and by many other less obvious criteria. On my return home I sent these specimens to Professor Pierre Fauvel, who kindly examined them and identified them as Lycaestis quadraticeps, a most aberrant Polychaet in several ways. It differs from the enormous majority of the Class Polychaeta and from all the other genera of the order (Nereidiformia) to which it belongs, in being hermaphrodite. Further, though so small, it has eggs which are relatively gigantic. Nearly all other Polychaetes have microscopic eggs.

This curious worm was discovered in the sea on the west coast of Chili and described in 1849 ; but the naturalist who named it missed its remarkable peculiarities. Nothing more was heard of it till half a century later, when it was found at Lapateia, Beagle Canal. A little later again it was found in the Straits

of Magellan. So far it had only been found in South America, and in the sea or in fresh water easily accessible from the sea. Now, a quarter of a century later, I found it 5,000 miles away, in a lake of absolutely fresh water 1,100 feet above the sea and separated from it by a large waterfall. I cannot hazard a guess as to how this most peculiar little animal should come to have such a most peculiar geographical distribution.

One of the most remarkable facts about the animals of the Lake is the absence (while we were there, at any rate) of biting mosquitoes. We had feared that we would be plagued with them, owing to the expanse of water providing such a large breeding-place. We were very pleasantly surprised to find our fears unfounded.

On the appointed day our carriers returned, and we went back to Nombur. Here we completed the investigations of the coral reef which I had started five years before and which are described in the next chapter. We had not waited many days at Nombur, when one morning before dawn we saw a light out to sea. We waved our lamp about to attract attention. Shortly afterwards a cutter put in through a breach in the reef further north. Mr. Thomas had most kindly sent his boat all the way from Hog Harbour, 75 miles away, to bring us back.

## Chapter VII

# A CORAL REEF

IN general one may say that whereas plants are an essential to almost any landscape, animals seldom affect one. There are some odd exceptions. A worm (Tubifex rivulorum), belonging to the same class (Oligochaeta) as the common earthworm, sometimes lives in such abundance in streams as to give a red colour which the artist must acknowledge with his brush. Vast swarms of Noctiluca (a Protozoon so small as scarcely to be visible to the naked eye) and other phosphorescent animals may light up the ocean at midnight. Millions of guillemots may change the aspect of sea cliffs almost as much as a covering of vegetation. But far more than any other animal the coral has impressed itself upon the scenery of the world. The reefs it builds up put to shame as insignificant the greatest marine barriers of mankind. The whole of many men's existence is spent upon circlets of calcium carbonate in the middle of the Pacific and other oceans, which would never have existed but for this laborious little creature.

Though its works are so well known, few who are not biologists have any idea of what the animal itself is like. The true coral or Madrepore is not closely

allied to the precious red coral of commerce. The latter should not properly be called a coral at all. To form an idea of a true coral one should imagine hundreds of little sea anemones, far smaller than the ones one sees in rock-pools round our coasts, all fused together into a more or less flat sheet of brightly-coloured living tissue. Although one cannot say precisely where one individual ends and another begins, yet each has its own mouth and a circlet of tentacles surrounding it, all the mouths being directed upwards. This sheet of living tissue, studded with mouths and tentacles above, deposits calcium carbonate below ; and in the simplest cases a rounded white mound of calcium carbonate is thus formed, to which the sheet of living tissue which has deposited it adheres firmly. In less simple cases calcium carbonate is deposited much more rapidly by certain parts of the lower surface of the sheet than by others, and a number of upright rods are thus formed, all of them clothed of course with the sheet of living tissue. If calcium carbonate begins to be deposited particularly rapidly in two or more places on an upright, then that upright has begun to branch ; and there is no limit to the amount of branching that may take place. Thus some corals are branched like bushes, others like trees ; and all sorts of peculiar shapes may be produced by deposition of calcium carbonate in peculiar ways.

The form of the skeleton of calcium carbonate is well adapted to the habitat in which the coral lives. In

the region of the breakers on a coral reef, a sea anemone would be swept away, hurled from rock to rock and crushed by the impact : but a solid encrusting or mound-shaped skeleton of calcium carbonate enables the coral to live in this precarious situation. In quiet waters a skeleton of this sort would be a positive disadvantage to the coral, for sand and silt, the deadly enemies of corals, would fall and accumulate upon it. In such situations a branched skeleton is an obvious requirement, for the little animals are thus held up away from all danger of suffocation by falling particles of sediment.

A single species of coral can commonly take on a wide variety of forms, according to the nature of the environment in which the larva that produces it chances to settle down. The microscopical larvæ of corals live free in the sea, and are carried passively about by currents till they grow old enough to settle down and grow a proper mouth and tentacles, bud off new individuals, and secrete a skeleton. If a larva is amid the rush of water under the breakers when it settles down, it will assume an encrusting or mound-shaped form even though it belong to a species which characteristically has a branching skeleton and lives in still water.

When a coral dies, its dead skeleton remains and forms a basis on which another may grow : and thus coral grows upon coral until a great reef is formed in the sea which reaches to the level of low spring tides.

Higher than this corals cannot grow, for they are killed by exposure to air in a very short time.

It is a remarkable fact that corals do not grow luxuriantly in the New Hebrides, for elsewhere in the tropical Pacific well-developed coral reefs abound. In New Caledonia and Fiji, between which the New Hebrides lie, there are splendidly developed barrier reefs, running roughly parallel with the shore and often many miles from it, broken here and there by breaches through which even large steamships may pass to lie safely in the untroubled waters of the lagoon. Elsewhere in the Pacific there are well-developed fringing reefs, differing from barrier reefs in lying close against the shores of islands, so that no lagoon or only a very shallow one exists. Elsewhere again in the same ocean there are ring-shaped reefs called atolls, encircling lagoons in which no land raises itself above the sea.

In the New Hebrides practically all the reefs that exist may be classified as fringing reefs. With a few exceptions they are small, and in no case to my knowledge do they completely surround an island. Their narrowness may be attributed partly to the steep submarine slopes from the shores of the islands ; for reef-corals can only grow down to a depth of about thirty fathoms, owing to the necessity of light for their existence. Thus fringing reefs can only extend beyond the 30 fathom contour by growing upon the rubbish-heap of coral-fragments which are broken off from the seaward edge of the reef in storms and fall

down to the sea-bottom just outside it. A moment's thought will show that outward growth on a basis of this sort must necessarily be very slow if the submarine slope is at all steep, and must stop altogether if it is so steep that the broken fragments fall right down into the depths of the ocean, far below the 30-fathom line.

The widest reef that I saw during my visits to the New Hebrides is that fringing the N.E. coast of the island of Gaua. At the place chosen for study it is about half a mile wide. Fig. 31 is a map of it. This must not be taken as an accurate representation, since distances were measured in paces and bearings were only roughly taken.

It will be noticed that near the seaward edge of the reef there is a double "boulder-zone". It very commonly happens that there is a ridge near the seaward edge of reefs, a foot or more above the water at low spring tides, with here and there a large boulder rising still higher. This ridge is formed of fragments of coral thrown up from the edge of the reef in storms, which become to some extent cemented together. The peculiar fact about the boulder zone here is that it is double, consisting of two incomplete ridges parallel with the edge of the reef, with a channel between them. I cannot account for its double nature.

The depth of the water varies considerably in different parts of the reef. Along the line carefully examined (marked Line 2 in the map) the bottom is

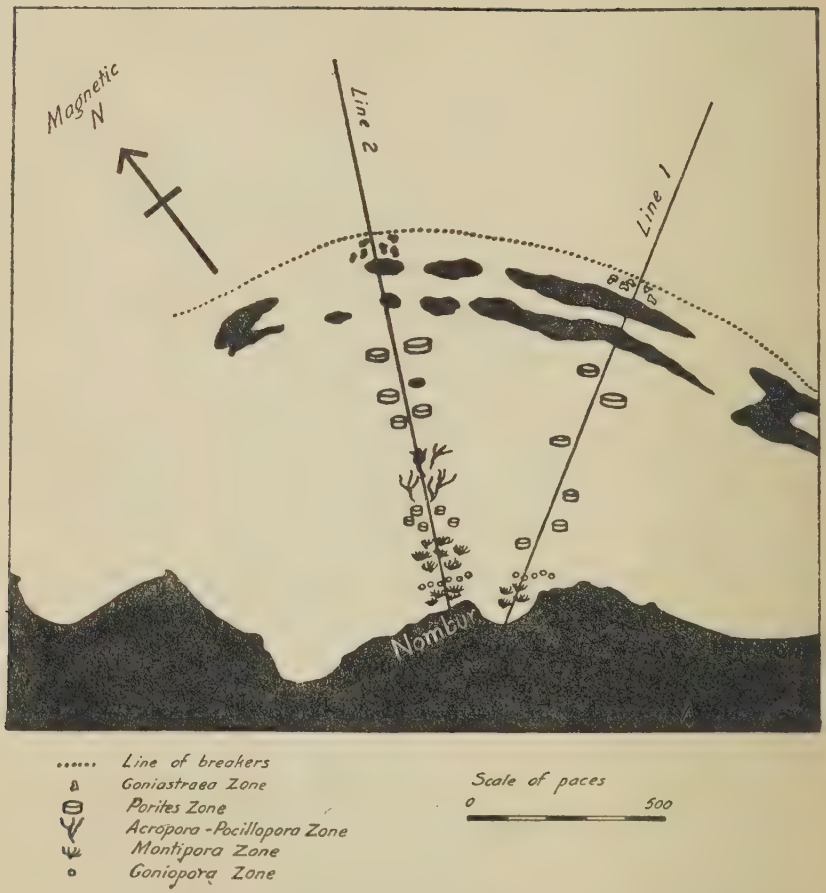



FIG. 31. MAP OF CORAL REEF AT NOMBUR, GAUA, SHOWING THE ZONES OF CORAL GROWTH DIAGRAMMATICALLY.

just awash near the island shore at low springs. Further seawards it becomes deeper, reaching 2 ft. 6 in. in places. Further out again it gets gradually shallower till it reaches the surface at the inner boulder zone. The channel between the boulder zones is a few inches deep at low springs.

Outside the outer boulder zone there is about two feet of water, though the amount varies from moment to moment as it is sucked outwards before the oncoming wave breaks, and then is thrown violently forward. The collection of corals in this region is very difficult, for it is often impossible to retain one's foothold in the rushing water. When one has nearly succeeded in breaking off a piece of coral with one's chisel-shaped crowbar, a breaker carelessly deposits one in a different part of the reef, from which it is impossible to find one's way back to the piece of coral at which one has been working. There is danger of injuring oneself when thrown about by the waves, for cuts made by living coral often ulcerate badly and take a very long time to heal.

As one walks out from the shore along Line 2, one finds that species which are common at one place are rare at another. The whole line is divisible into zones, each zone having a few species to characterize it by their abundance. There is not generally a sharp line of demarcation between one zone and the next. The abundance of the commoner species in each zone is shown in the diagram. (Fig. 32.)

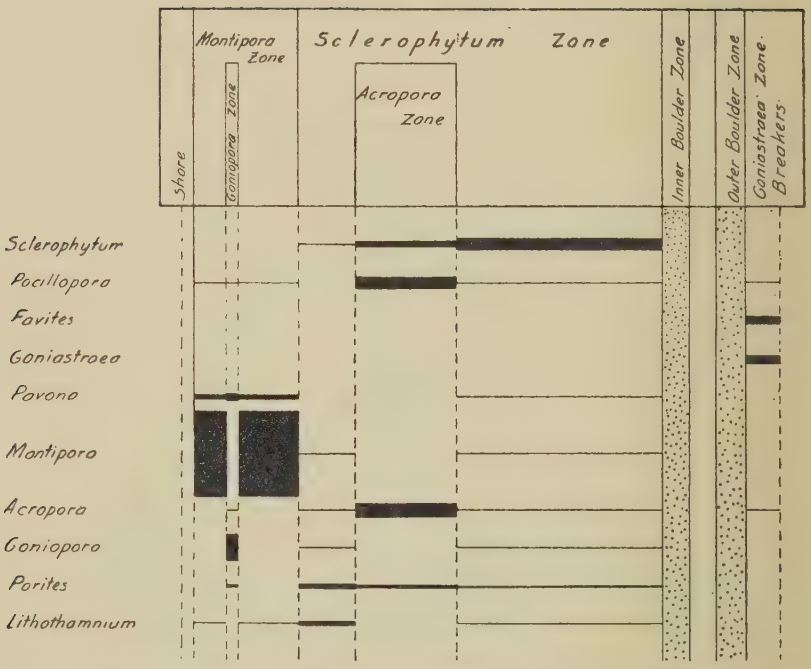



FIG. 32. DIAGRAM SHOWING THE ABUNDANCE OF THE COMMONER CORALS AND OTHER SESSILE ORGANISMS IN THE VARIOUS ZONES ON THE REEF AT NOMBUR. The abundance of each species in each zone is proportional to the thickness of the black stripe opposite its name.

Some of these species are shown in the photo. (Fig. 33.) (See Plate, pp. 146–7.)

*Montipora zone.*—One meets with no coral growth for the first twenty-five yards from the shore. Then rather suddenly the first zone begins. Here the growth of coral is richer than anywhere else on the reef, except perhaps on the outer seaward slopes where one cannot study it. I estimate that about 85% of the ground is covered with living coral. The fragile much-branched species Montipora ramosa Bernard is dominant here. Probably this species is specially adapted to live in water of slightly less salinity than the open ocean, and thus has an advantage over other species in this region ; for there is considerable seepage of fresh water into the sea along the coasts of the New Hebrides, owing to the heavy rainfall and the porous nature of the rocks.

*Gonipora zone.*—In the middle of the Montipora zone there is a strip of ground about fifteen yards wide whose corals are strikingly different. Here the commonest coral is Goniopora tenuidens Quelch, which grows in the form of rounded mounds a foot or more in diameter. About 35% of this area is covered with living coral.

*Sclerophytum zone.*—This occupies the greater part of the broad sandy area between the Montipora zone and the inner boulder-zone. It is characterized alike by its poverty in amount of growing coral, and its richness in number of species. The Alcyonacean Sclerophytum (allied to the " dead men's fingers "

of our own coasts) and the coral Porites fragosa Dana are the least rare species. These, together with more than a dozen other species, cover only about 10% of the area.

*Acropora zone.*—In the middle of the Porites zone is a belt in which there is much more coral growth, about 35% being covered. The two dominant forms are a large thick-branched Acropora and Pocillopora bulbosa Ehrenberg. The latter has a compact bush-like form. These two are not mixed with one another, but each occurs in areas of some 20 ft. by 20 ft. to the exclusion of the other. The areas in which Pocillopora grows reach almost to the surface at low spring tide, and examination of the substratum shows that Pocillopora has been the coral responsible for the upgrowth. Walking carelessly on one of these raised Pocillopora areas, one falls suddenly to waist-depth into a bright blue Acropora area, in which not a Pocillopora is to be seen. I do not know the cause of this sharp separation of the two species.

*Boulder zone.*—On the ridges themselves there are no corals, since they are dried off for considerable periods at low springs. In 1922 I only saw three lumps of coral in the channel between them. When I returned to the reef in 1927 I was therefore very much surprised to find quite an abundant growth of a small bush-like Acropora in the boulder-zone channel along Line 1. (I did not examine the boulder zone channel in the region of Line 2 during my second visit.) Fig. 34

is a photograph of a piece of this coral, which had grown up in less than five years. A shilling piece placed on the specimen gives the size. (See Plate, pp. 146–7.)

*Goniastraea zone.*—We come now to the zone which is always agitated by the surf from the waves breaking on the edge of the reef. As was mentioned before, the rush of the water is so great that it is difficult and often impossible to stand. It is therefore not surprising that the whole appearance of the coral growth is different from that between the boulder zones and the land. Encrusting and amorphous forms and forms with short thick branches are characteristic. The two most abundant species are Goniastraea pectinata Ehrenberg and Favites abdita Ellis and Solander. The encrusting species both have rather large individuals. Perhaps 15% of the area is covered with growing coral. Although no pretence of accuracy is attached to this figure, yet it shows clearly what a relatively barren zone this is. Corals are often supposed to grow more luxuriantly in the wash of the breakers than anywhere else. On this reef at any rate such is far from being the case. Goniastraea, the dominant coral of the zone, tends to grow on that side of the boulders which is turned away from the breakers.

The absence or extreme rarity in the Goniastraea zone of the encrusting calcareous plant Lithothamnium is interesting, for in many coral reefs it covers everything in this zone and gives it its name.

Along Line 1 (see Fig. 31) the Montipora,

Goniopora, Sclerophytum and Goniastraea zones can be recognized, but the Sclerophytum zone is even poorer in living corals than along Line 2 and there is no Acropora zone.

While corals are busily engaged in building up a reef, other agencies are at work on its destruction. To a small extent the calcium carbonate is carried away dissolved in the sea water. But the action of waves and currents is a more important factor, for pieces of coral are torn off and rubbed against others and thus finally reduced to sand. Such pieces might not even then be irretrievably lost to the reef, were it not for certain animals which pass this coral sand through their bodies and reduce it to a still finer state of subdivision. After their attention it may become suspended in the water and thus carried out to sea through breaches in the reef by the scouring action of the tides. The object of the animals which do this is to digest the microscopical organisms which inhabit the sand. Chief among the organisms which pass coral sand through their bodies for this purpose are the Holothurians or sea-cucumbers, whose popular name well describes their outward form and size if not their soft consistency. One would never think on casual examination of one of these sluggish creatures that they belong to the same branch of the animal kingdom as the sea-urchin and starfish.

Four species of Holothurians occur on the reef at Nombur. *Stichopus chloronotus* Brandt is about nine

inches long and roughly quadrangular in transverse section, with papillae along the angles. *Holothuria atra* Jaeger is a foot long, brownish black, cylindrical, and usually coated with particles of sand. *H. vagabunda* Selenka is smaller than *H. atra* and of a lighter brown ; it has many long pointed papillae and emits sticky white threads very readily. *Actinopyga mauritiana* (Quoy and Gaimard) is much larger than the others. It is rather pale brown in colour, and the area on which the numerous little appendages known as " tube-feet " occur is very broad and flat.

It was at Mr. C. S. Elton's suggestion that my wife and I studied the distribution of the Holothurians on this reef on the occasion of my second visit. Although nothing was previously known about the zonation of Holothurians on coral reefs, yet Mr. Elton thought it probable that each species would have a distinct zone in which it flourished. His expectations could hardly have been better realized. A walk over the reef along Line 1 soon showed us that these creatures were very far from being distributed at random. The Montipora zone, the Sclerophytum zone, the boulder-zone channel and the Goniastraea zone each has a characteristic Holothurian. In order to get absolute figures for the abundance of each species in each zone, a place was chosen in each wholly at random, and an area of five by five paces marked out by stones set at the corners. The random method of choosing the sites of these areas consisted of throwing

a stone and noting where it fell. All the Holothurians within the areas were counted. Table 8 shows the results :—

Table 8.

| | Stichopus. | H. atra. | H. vagabunda. | Actinopyga. |
|---|---|---|---|---|
| Montipora zone . . | 145 | 8 | 0 | 0 |
| Sclerophytum zone . | 0 | 142 | 0 | 0 |
| Boulder-zone channel . | 1 | 13 | 10 | 0 |
| Goniastraea zone . | 0 | 1 | 0 | 12 |

The following account of each zone is based upon a general survey of the reef, not simply upon the counts recorded above.

*Montipora zone.*—*Stichopus* and *H. atra* are the only Holothurians here (as they are also in the narrow strip between this zone and the shore). Their abundance varies enormously according to whether much or little of the coral is alive. In places where only about 10% of the area is covered with living coral, they are extremely numerous, as the Table shows ; for no fewer than 145 Stichopus were taken in a random area of 25 square yards in a bare part of the zone. This means that there are between five and six of these large creatures to every square yard. In an area of 25 square yards, of which about 70% was covered with living coral, there were only eight Holothurians. This is presumably to be accounted for by their congregating chiefly where there is plenty of sand.

We made no special observations on the Holothurians of the narrow Goniopora zone.

*Sclerophytum zone.*—In this broad sandy zone, in which there are between five and six *H. Atra* in every square yard, we did not see any specimens of the other three species.

*Boulder-zone channel.*—The boulder-zones, being dried off even at low heaps, are free from Holothurians as well as living coral. In the channel between them *H. atra* and *H. vagabunda* occur, but not abundantly. *H. vagabunda* seems to be confined to this narrow zone. Perhaps this is on account of the large number of loose pieces of coral rock here, for it usually lies with part or the whole of its body under stones. *Stichopus*, which seems to be absent from the Sclerophytum zone, occurs again here, but in much smaller numbers than the other two species.

*Goniastraea zone.*—Here, amid the rush of the breakers, *Actinopyga* occurs for the first time. *H. atra* also occurs, but much less abundantly than *Actinopyga*. The latter appears well adapted to the rushing water by its broad flat tube-foot area, by means of which it clings firmly to the substratum. *H. vagabunda* and *Stichopus* are absent.

The distribution of the four species may be summarized as follows :—

*Stichopus chloronotus* flourishes near the shore, particularly in those parts of the Montipora zone in which there is little growing coral. It occurs

again, but not at all abundantly, in the boulder-zone channel.

*H. atra* occurs everywhere, from the shore to the breakers, but is much more abundant in the Sclerophytum zone than elsewhere.

*H. vagabunda* is confined to the narrow boulder-zone channel.

*Actinopyga mauritiana* is confined to the rushing water of the Goniastraea zone.

This striking zonation of the Holothurians presents problems of great difficulty. It is almost as though in a garden of uniform soil one were to find one species of earthworm in the flower beds, another in the vegetable garden and another among the fruit trees, yet all three were eating the same thing, namely earth. How do these Holothurians come to distribute themselves as they do? One can hardly suppose that their microscopic larvæ, which are carried about passively by currents, can decide where they shall settle, nor yet that such sluggish creatures should travel such long distances as would be necessary to distribute themselves in a definite way by voluntary movement after the settling of the larvæ. The only easily understood fact is that if the larva of *Stichopus* or *H. vagabunda* were to settle amid the breakers in the Goniastraea zone, it would probably be hurled from rock to rock and killed. But why should not *Actinopyga* invade the still waters between the boulder-zone and the shore? Its larvæ must certainly often

settle there. Why should not *Stichopus*, which is so enormously abundant in bare parts of the Montipora zone, thrive also in the bare Sclerophytum zone, where *H. atra* now reigns supreme ?

If I had time to make an extended study of these problems, I would put a few hundred *Actinopyga* and a few hundred *H. vagabunda* and a thousand *Stichopus* in the Sclerophytum zone, just to see what would happen to them and to find out if possible why they seem never to occur there naturally.

Let us turn now from these fascinating problems presented by the sea-cucumber to the grander question of the origin of the reef on which they live and which they are trying, unsuccessfully, to destroy.

It is usually supposed that corals begin to grow wherever the water is sufficiently shallow ; that continued growth brings them to the surface ; and that boulders of coral rock broken off by the breakers fall down the seaward edge of the reef, and form a sort of rubbish-heap on which the reef grows further out to sea. If the shore of the fringed island is overhung by cliffs, it is taken for granted that the cliffs were formed by the action of the breakers before the reef grew up. This theory is illustrated in Fig. 35 ; it may be summed up in the words that a fringing reef increases its breadth only at its seaward edge.

I believe this to be a mistaken view. My theory is illustrated in Fig. 36. I think that when a volcanic island is elevated above the sea in the tropics, two

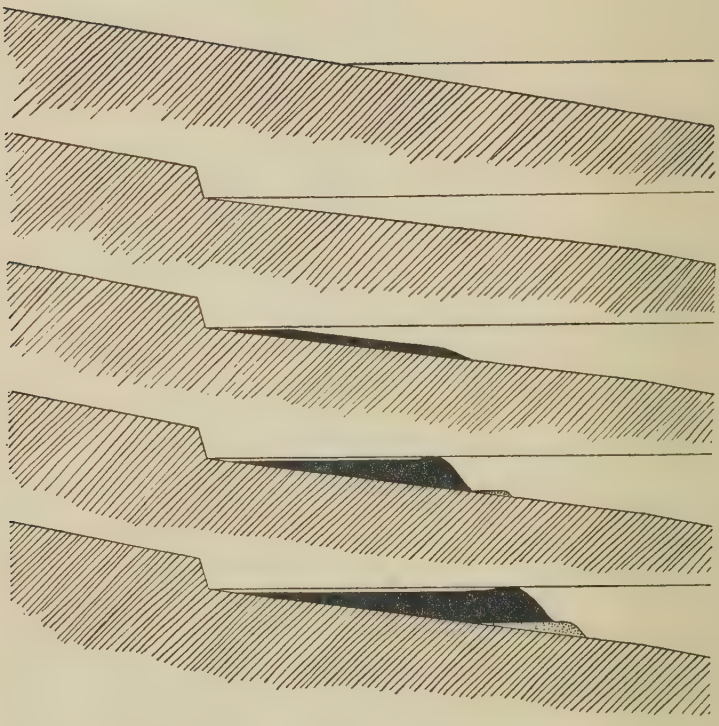


Fig. 35. Diagram Showing the Accepted Theory of the Origin and Growth of a Fringing Reef. Parallel lines represent rock; spots represent the heap of coral fragments that have fallen down over the edge of the reef. The horizontal line represents sea-level. The blacked-in part is coral.

*By kind permission of the Zoological Society of London.*

processes begin to take place. Firstly, corals begin to grow everywhere on the submarine slope to a depth of 30 fathoms ; secondly, the sea starts to batter down the land, and in places to form cliffs. But when the coral reef has risen to the surface, *the battering down of the land does not cease ;* on the contrary it continues and the shore recedes. Tides and currents scour away the ground to a depth of a few feet below low spring tides. The presence of a coral reef outside the original shore-line prevents much *submarine* erosion, so that a flat platform is left as the shore recedes. Upon this shallow platform corals grow. The casual observer cannot say how much of the reef is a thick layer of coral rock extending down to the old submarine slope, and how much is merely a veneer over a flat platform lying where there was originally land. A series of borings would immediately settle the question. According to my theory a fringing reef not only grows outwards on its heap of fallen boulders, but also inwards on the shallow platform produced by the erosion of the shore.

With reference to the suggestion that land may be eroded within a reef, Wood-Jones[1] says :—" The picture of the high island . . . when, after having stood resisting in a troubled sea, it so conveniently crumbles to pieces within the calm of an encircling barrier reef, appears to me to be contrary to all natural laws." Nevertheless during rough weather I have myself seen the water near the shore *discoloured* by

[1] *Corals and Atolls* (Lovell Reeve, London), p. 224.

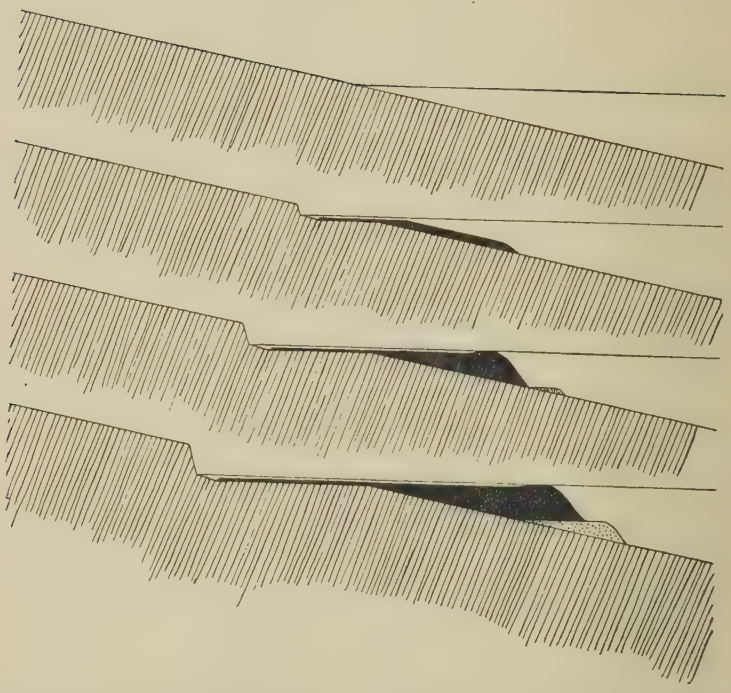


Fig. 36. Diagram Showing the Author's Theory of the Origin and Growth of a Fringing Reef. (Compare Fig. 35.)

*By kind permission of the Zoological Society of London.*

Fig. 37. The Cliff at Nombur, showing erosion.
(*Photo by the Author.*)

[*To face p.* 174.

suspended particles of the volcanic tuff that forms the cliff near Line 1. A missionary assures me that during gales spray is thrown right over the cliff, which is about fifteen feet high. (Fig. 37.) The coconut trees, which were planted about twenty years before my visit, bear strong evidence in favour of erosion. It is quite incredible that anyone would have planted coconuts so near to the edge of a cliff as they are now. Their roots are exposed on the face of the cliff. Very considerable erosion has evidently taken place in twenty years.

Another piece of evidence indicating that the reef has grown inwards towards the shore is afforded by the great flat-topped masses of Porites which occur everywhere between the boulder zone and the shore (particularly in the Sclerophytum zone). The biggest of these, some six feet in diameter, are furthest from the shore, the smallest close to it. It would appear that there has not been time for the growth of very large Porites near the shore, owing to the shore having only comparatively recently been eroded in this region. This must, however, remain a speculative argument until more is known of the length of time that Porites is likely to take to grow to a diameter of six feet, and of the effect of local environmental conditions in determining its rate of growth.

## Chapter VIII

# THE ASCENT OF MT. TABWEMASANA

IN the old Admiralty Charts of Espiritu Santo, the highest mountain marked is Losubunu or "Santo Peak" (5,520 ft.), in the S.W. of the island. The two previous attempts to climb the highest mountain in the New Hebrides were attempts on Losubunu. The first was made by Mr. (now Sir) Douglas Mawson, the second by Dr. F. Speiser. Mr. Mawson seems not to have ascended much above 4,000 feet. Dr. Speiser, on the contrary, seems nearly to have attained the summit, but unfortunately he did not survey his route.

The map of the French Ministère des Colonies and a more recent edition of the Admiralty Chart prove that Losubunu or "Santo Peak" is *not* the highest mountain. Both these maps mark a higher peak considerably further north, inland from the coastal village of Wus. The height is given in the French map as 1,880 metres, in the Admiralty Chart as 6,169 feet. This mountain, which is not named in the maps, is Tabwemasana, the highest mountain in the New Hebrides.[1]

[1] Between Tabwemasana and Losubunu is a double peak of 5,488 feet, almost the same height as Losubunu.

## ASCENT OF MT. TABWEMASANA

I was accompanied on the ascent of Tabwemasana by Mr. T. O. Thomas and Mr. J. de H. Morel. The latter took all the photographs of the mountain expedition which are reproduced here.

Starting in a southerly direction we sailed round the island in Mr. Thomas' cutter and arrived on the third day at Tasiriki, just past the S.W. corner of the island. We did not proceed further that day, on account of the heavy tide-rip which we saw extending all the way to Wus and which would almost certainly have made the anchorage there unsafe. A few natives came from the village to see us. We explained our project and told them we wanted volunteers to carry.

At Tasiriki there live a white man and his wife, engaged chiefly in the cultivation of coconuts. All the way up the west coast from here the country is mountainous, with scarcely any level ground on which to make a plantation. Further, there are no harbours, nor even an anchorage which is safe with a westerly swell. It is not surprising that there is only a single European living on the 100 miles of coast stretching round from Tasiriki to near the S.W. corner of Big Bay. (Needless to say, there is no European living inland.)

Two days later three men and four boys who had volunteered as porters came on board early. One of them was a murderer who had fled from the rough justice of his native village and was delighted to find safety with us in the mountains. We sailed twenty

miles up the coast and were able to anchor safely at Wus, the direction of the wind being favourable. The Rev. F. G. Bowie, who had most kindly put his valuable knowledge of the west coast of Espiritu Santo at our disposal, had sent word a long time before to the people of Wus that we were coming. It was largely owing to this that we were able to get sufficient porters. In all, counting those we had collected at Tasiriki, we had sixteen. This was just sufficient. One was a boy with a sore on the sole of one of his feet, which caused him to hobble rather than walk. He was determined to come, and he did ; but it is stretching the point to describe him as a carrier.

Fig. 38 shows our route from Wus to Tabwemasana. The coast-line is from the map of the French Ministère des Colonies ; the rest is from my survey. The map was drawn from my survey by my brother, Mr. S. J. Baker, and re-drawn for publication by the draughtsmen of the Royal Geographical Society, to whom I am much indebted for permission to reproduce it here. Distances were measured by time on the march, directions by prismatic compass, and altitudes by $4\frac{1}{2}$ inch aneroid barometer, checked against three-hourly readings of an identical barometer at sea-level. The sea-level readings were kindly taken by Mr. O. Stevens, who was in charge of the cutter during our absence inland. The form-lines are 200 feet apart. The elevations of places not on our route are only estimated.

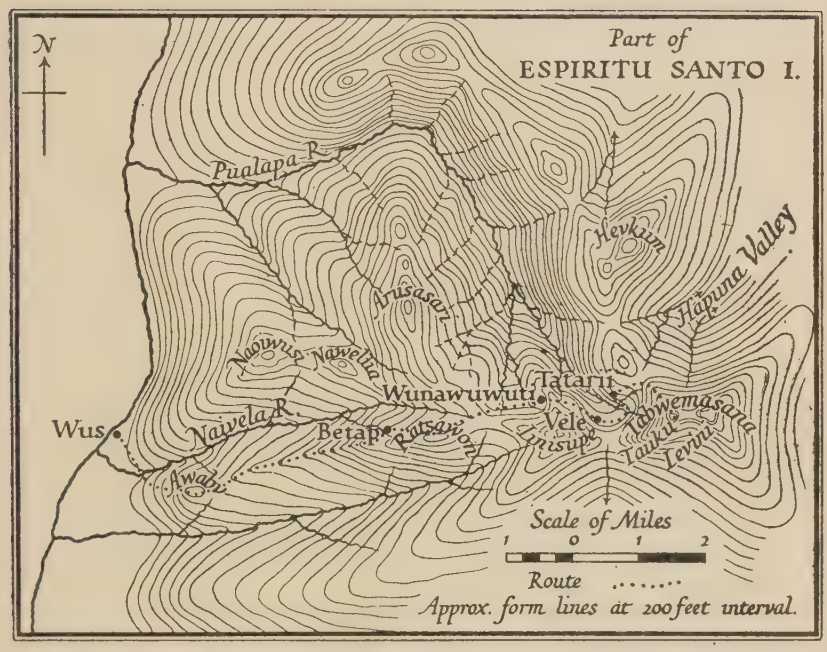



FIG. 38. MAP SHOWING THE AUTHOR'S ROUTE FROM WUS TO MT. TABWEMASANA.

*By kind permission of the Royal Geographical Society.*

We left Wus on 5th July, 1927. After crossing the River Naivela we made a steep ascent on to the crest of the Awabv ridge. Once we were on it, ascent was more gradual for a couple of miles. The crest of the ridge is only a foot or two wide in many places, with steep slopes on both sides. In many places forest vegetation extends right up to the ridge on the southern slope, and long grass right up to the ridge on the northern slope, giving a most curious aspect to the scene. Grassy vegetation occurs naturally nowhere in Espiritu Santo except on the northerly faces of the western chain of mountains. Everywhere else there is dense forest. Probably the cause of the curious distribution of the grassy lands is the greater humidity of the southern slopes, owing to the sun being to the north during the greater part of the year.

A sharp ascent, followed by a slight descent to a small tributary of the Naivela, brought us to the little village of Bētap, at 3,500 feet. Here we camped for the night, sleeping in one of the huts. Several of the people of Bētap joined our party as porters.

Next day, after a small climb, we crossed the crest of a range of four mountains which I shall call the Linisupe-Arusasari range from the names of two of the mountains. This range leads to Tabwemasana. Beyond it, to the north and east, lies the valley of the River Pualapa, and beyond the valley another range of mountains, which I shall call the North Pua range, which also leads to Tabwemasana.

Fig. 39. The author's party just after crossing the crest of the Linisupe-Arusasari Range. Note grassy vegetation.

*(Photo by Mr. J. de H. Morel.)*

*By kind permission of the Royal Geographical Society.*

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Fig. 39 shows the party just after crossing the crest of the Linisupe-Arusasari range. Mt. Arusasari is immediately behind the party. The vegetation here on the northern slopes of the range is grassy, except in the little valleys of streams running down to the River Pualapa, where there are wooded patches. Without changing our elevation very much we now walked along the north side of the crest of the range almost directly towards Tabwemasana, passing the deserted villages of Wunawuwuti and Velē. Between these two villages, on a spur running down into the valley from Mt. Linisupe, is a bare patch of ochreous ferruginous clay. It is curious that the natives of the New Hebrides should be ignorant of the smelting of iron from its ores, when it is so abundant.

About half a mile past Velē we were at the base of Tabwemasana itself. Our guides brought us across the little stream called Riris, which rises on Tabwemasana and forms the highest source of the River Pualapa. We next began to ascend the North Pua range, and camped for the night at the village of Tatarii (4,000 ft.). We were very cold in our little huts at Bētap and Tatarii, after the steaming heat of the New Hebridean climate at sea-level. Fig. 40 is a photograph of Tabwemasana taken from Tatarii.

On the morning of the 7th we started early. Our first move was to attain the crest of the North Pua range. This we did at a pass leading over into the Hapuna valley. The River Hapuna flows into Big Bay

some miles west of the outflow of the River Yoro. From the Pualapa-Hapuna pass we could see the large lake-like expansions which the Yoro forms before narrowing suddenly to flow out to sea.

Turning to the right, we now climbed along the ridge forming the continuation of the North Pua range on Tabwemasana itself. I may here quote from my journal : " It was a steep climb along a knife-edge ridge nearly the whole way. It would have been quite impossible to climb had there been no vegetation. We clambered up from branch to root and root to branch, always with an almost sheer drop on each side. A considerable part of the ridge is clothed with Pandanus. None of our twenty-six porters had been at the summit before. One of the sea-coast natives said afterwards,' My word, you no look me ; me me shake-shake all time '." Actually there was no cause for alarm, as one could not have fallen far through the thick vegetation.

We arrived at the summit at 10.53 a.m. The actual summit of the peak we had climbed is only two or three square feet in area. Here we half buried a bottle containing an account of our ascent. The vegetation of the summit consists of trees on every side (Fig. 41), among them Metrosideros collina, (Forst.) Gray. The thermometer registered shade temperatures of 61·5°, 61·5° and 62° F. at 12, 1 and 2 o'clock. 62° F. (= 16·7° C.) must have been the maximum for the day. It is not surprising that

Fig. 40. Mt. Tabwemasana from Tatarii.

*(Photo by Mr. J. de H. Morel.)*

*By kind permission of the Royal Geographical Society.*

[*To face p.* 182.

Fig. 41. At the summit of Tabwemasana Tauku.
*(Photo by Mr. J. de H. Morel.)*

[*To face p.* 183.

our carriers felt very cold. The *minimum* temperature for the same night and day at Hog Harbour was 72° F.

The rock forming the summit is Augite-Andesite. A full description of it is given in Appendix 2.

Visibility was excellent from north-east to west, but dense fog prevented us at first from seeing anything to the east. The natives had told us that Tabwemasana was a double peak, one of the peaks (that which we had climbed) being called *Tauku* (= man) and the other *Levini* (= woman). They all said that Tauku was the higher. Shortly before we left the fog lifted and we got a splendid view of Levini. I at once took out my clinometer and found that our informants were wrong, Levini being nearly 7° above the horizontal from the summit of Tauku. My corrected barometer reading gave 6,025 feet as the height of the summit of Tauku, which compares well with the Admiralty Chart figure of 6,169 feet, which presumably represents Levini.

Fig. 42 is a view down the Pualapa valley from near the summit of Tabwemasana Tauku. The north Pua range is on the right, and some of the mountains of the Linisupe-Arusasari range on the left.

We had intended to camp at the summit overnight so as to make as thorough a collection of the fauna as possible and to record the minimum night temperature, but owing to the cold nothing would induce our carriers to stay with us, nor would they agree to come back next day for our camping gear if the white men of the party stayed there alone overnight. They had

therefore carried all our camping gear and food to the summit to no purpose, and we had to return to Tatarii for the night.

The whole party was engaged during the greater part of our stay at the summit in making a collection of the fauna. The following is a list of the animals collected, as far as they have been worked out by specialists in the various groups. The new varieties and species are in italics.

| | |
|---|---|
| Platyhelminthes . | Platydemus quadristriatus (Grube). |
| Crustacea . . | *Orchestia platensis*, Kröyer. |
| Hemiptera . | *Vitellus* sp. nov. |
| | *Luteva* sp. nov. |
| | *Nesaphrestes* sp. (? nov.). |
| Coleoptera. . | *Paederus* sp. (? nov.). |
| | *Leptocyrtinus* sp. (? nov.). |
| | Ceratia quadrimaculata, F. |
| Lepidoptera . | *Hypenodes costistrigalis* Stph. var. |
| Diptera . . | *Adelphomyia* sp. (? nov.). |
| | *Callophora* sp. (? nov.). |
| | Syrphus sp. |
| Gastropoda . | *Aneitea robsoni*, Hoffmann. |

Of the thirteen species, no fewer than ten are peculiar and eight appear to be new species. The little yellow beetle with four black spots, called Ceratia quadrimaculata, was the only species among them which I had previously found in the islands in a year's collecting.

The animal which surprised me most was the Amphipod, Orchestia platensis, Kröyer. The Amphipods are a group of small, flattened, superficially

shrimp-like Crustacea, which one often sees swimming about on their sides in fresh water. Nearly all the members of this group are marine or freshwater, and I could hardly believe my eyes when I saw them at the very summit of the mountain, more then 6,000 feet above the sea and far from any stream or pond. Nowhere else in the New Hebrides did I see a terrestrial Amphipod. Professor W. M. Tattersall kindly examined my specimens and identified the species. They differ from the normal in one point, but are apparently to be regarded as of the same species.[1] This species is very widely distributed, being found in North and South America, Africa, India, the Low Archipelago in the Pacific and elsewhere. *With one exception it has never been taken except on the sea-shore at or near high tide mark.* It would have been almost as peculiar to have found a limpet 6,000 feet above the sea.

That evening at Tatarii I offered two cases of tinned meats to any two natives who would help us to make an attempt on Levini the next day. Even this (to them) enormous bribe failed to draw a single man. They insisted that the ascent of Levini was everywhere precipitous. This had certainly not appeared to me to be the case, when I had viewed it from the summit of

[1] The outer ramus of the 1st pleopod bears a row of four or five spines along its posterior margin, which are absent in the normal form.

Tauku ; but they assured us that although several natives had climed Tauku in the past, no one had ever been able to achieve the ascent of Levini. Mr. Thomas added a further bribe, but to no effect. The work of cutting a path for ourselves as well as carrying food, water and camp equipment would have been impossible without native assistance, so we were forced to abandon the project.

We remained at Tatarii that night, and returned by the same route as that by which we had ascended, sleeping once more at Bētap on the way.

The name " Santo Peak ", as a synonym for Losubunu, gives the misleading impression that this is the highest mountain in the island. Since Tabwemasana and not Losubunu is the highest mountain, the name " Santo Peak " should be discarded. Though Tabwemasana is not a large mountain, yet it cannot be denied a certain grandeur, rising as it does to its six thousand feet within ten miles of the sea.

Fig. 42. View down the Pualapa Valley from near the summit of Tabwemasana Tauku. On the left is the Linisupe-Arusasari Range, on the right the North Pua Range.

*By kind permission of the Royal Geographical Society.*

[*To face p.* 186.

# APPENDICES

## Appendix I

## NATURAL PYRAMIDS ON A BEACH

I came across a curious geological phenomenon on the black sandy beach to the east of the mouth of the River Yoro, in Big Bay, Espiritu Santo.

All the way along the beach for three or four miles there extends a row of piles of pebbles. Most of these piles are a couple of feet high in the middle and a dozen paces across. They are covered at high tide and exposed (or only partly covered) at low tide. The constituent pebbles, of black volcanic rock, are mostly oval in shape, somewhat flattened, and perhaps three or four inches long. Between one pile of pebbles and the next there is an expanse of sand, several paces across, which is almost bare of pebbles. There is a tendency for the piles to assume a definite shape (Fig. 43, upper figure), namely the shape of a very low three-sided pyramid, inclined on the beach in such a way that the landward side of the pyramid is almost level (lower figure). In some cases a second, smaller pyramid has been plastered on, as it were, to the seaward side of a larger one (right-hand side of upper figure). Each pile of pebbles rests on a similarly-shaped accumulation of sand ; and where there are no pebbles, the sand alone continues the succession of pyramids.

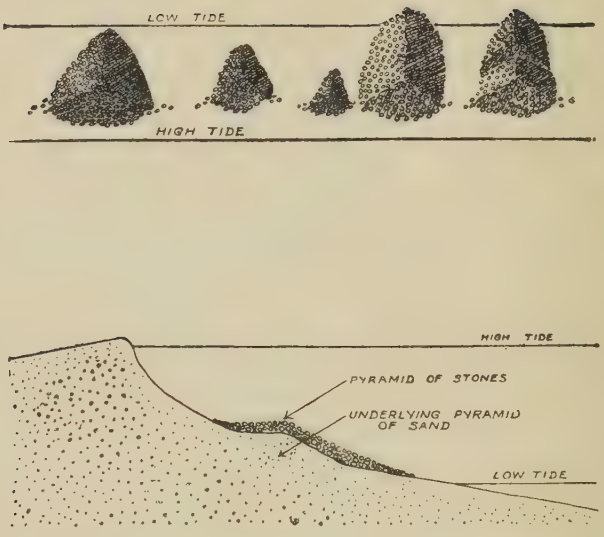


FIG. 43.—NATURAL PYRAMIDS OF PEBBLES ON THE BEACH NEAR THE MOUTH OF THE RIVER YORO, ESPIRITU SANTO. The lower figure is a vertical section of the beach; the upper is a view of part of the beach in plan. Both are diagrammatic.

*By kind permission of Messrs. Macmillan & Co., Ltd.*

I erected sticks to mark the position of two well-formed pyramids, to see whether they would shift their position at all. Next day one of them was as before, while the other had shifted slightly, and a small one had arisen between them. Two days later again the two marked pyramids had *disappeared*, one completely, and the other so nearly completely that I should not have guessed of its previous existence had I not marked it before.

It is perhaps significant that I noticed a strong current running in a westerly direction parallel to the shore.

This curious row of low pyramids extends along the beach to the west of the mouth of the river also; but here the phenomenon is less clearly defined, for the pebbles are much more numerous and the pyramids are not separated by bare areas. At Tasiriki, near the S.W. corner of the island, there is a somewhat similar row of piles of pebbles.

## Appendix 2

## NOTE ON THE GEOLOGY OF THE SUMMIT OF MT. TABWEMASANA TAUKU

Mr. C. J. Bayzand has kindly examined the specimens of rock which we took from the summit of Mt. Tabwemasana Tauku. He finds that the rock is Augite-Andesite. On microscopical examination of sections of the rock, the ground-mass is seen to be fine-grained, with lath-shaped crystals of colourless plagioclase and fairly abundant magnetite. There are large, well-defined phenocrysts of augite, yellowish to light green in colour.

## Appendix 3

## LIST OF PAPERS ARISING FROM THE AUTHOR'S RESEARCHES IN THE NEW HEBRIDES


Baker, J. R. . . 1928. *Ann. Mag. Nat. Hist.*, Ser. x, vol. ii, pp. 294–302. "The non-marine vertebrate fauna of the New Hebrides."

" " 1928. *Brit. Journ. Exp. Biol.*, vol. vi, pp. 56–64. "A new type of Mammalian intersexuality."

" " 1929. *Geographical Journal* (in press). "The Northern New Hebrides."

" " 1929. *Journ. Ecol.*, vol. xvii. "On the zonation of some coral reef Holothuria".

" " 1928. *Journ. Roy. Anthr. Inst.*, vol. lviii, pp. 279–303. "Depopulation in Espiritu Santo, New Hebrides."

" " 1928. *Man*, vol. xxviii, pp. 113–18. "Notes on New Hebridean customs, with special reference to the intersex pig."

" " 1928. *Nature* (in press). "Natural pyramids on a beach in the New Hebrides."

" " 1925. *Proc. Zool. Soc. Lond.*, vol. lxvi, pp. 1007–19. "A Coral Reef in the New Hebrides."

Edwards, F. W. . 1929 ? *Ann. Mag. Nat. Hist.* (in press).

Gist Gee, N. . 1928 ? *Ann. Mag. Nat. Hist.* (in press).

Kinnear, N. B. . 1928. *Bull. Brit. Ornith. Club*, vol. lxviii, p. 56. (Note on a new species of pigeon.)

Lowndes, A. G. . 1928. *Ann. Mag. Nat. Hist.*, Ser. x, vol. i, pp. 704–12. "Freshwater Copepoda from the New Hebrides."

Parker, H. W. . 1925. *Ann. Mag. Nat. Hist.*, Ser. ix, vol. xv, pp. 298–300. "Notes on lizards from the South Pacific Islands."

Pearman, J. V. . 1928. *Ent. Monthly Mag.*, vol. lxiv, pp. 133–7. "Some Psocoptera from the New Hebrides."

PICKFORD, G. E. . 1929. *Ann. Mag. Nat. Hist.*, Ser. x, vol. iii, pp. 493–8. "On an interesting earthworm from the New Hebrides."

TATTERSALL, W. M. 1929? *Ann. Mag. Nat. Hist.* (in press). "A terrestrial Amphipod from 6,000 feet in the New Hebrides."

THOMAS, O. . . 1925. *Ann. Mag. Nat. Hist.*, Ser. ix, vol. xvi, pp. 240–1. "On some Mammals from the New Hebrides."

WILLEMSE, C. . 1925. *Trans. Ent. Soc. Lond.*, pp. 513–29. "Contribution à la faune des Orthoptères des Nouvelles Hébrides."

WOMERSLEY, H. . 1928. *Ann. Mag. Nat. Hist.*, Ser. x, vol. ii, pp. 55–61. "Apterygota from the New Hebrides."

The following papers are only partly concerned with the author's researches in the New Hebrides :—

BAKER, J. R. . . 1925. *Q.J.M.S.*, vol. lxix, pp. 689–701. "On the descended testes of sex-intergrade pigs."

" " 1925. *Brit. Journ. Exp. Biol.*, vol. ii, pp. 247–63. "On sex-intergrade pigs: Their anatomy, genetics, and developmental physiology."

POULTON, E. B. . 1926. *Proc. Ent. Soc. Lond.*, Meeting of 3rd November, pp. 47–54. "The Euploeine associations of the New Hebrides and their relation to those of Fiji."

" " 1924. *Trans. Ent. Soc. Lond.*, 15th April, pp. 564–691. "Mimicry in the butterflies of Fiji . . ."

## Appendix 4

## LIST OF NEW SPECIES COLLECTED BY THE AUTHOR.

(*For references to the descriptions of the new species, see Appendix* 3.)

| | |
|---|---|
| Mammalia . | *Pteropus bakeri*, Thos. |
| Aves . . | *Muscadivora bakeri*, Kinnear. |
| Diptera. . | *Trentepohlia* sp. (? nov.). |
| | *Adelphomyia* sp. (? nov.). |
| | *Nephrotoma* sp. (? nov.). |
| | *Chiasmoneura cyclophora*, Edwards. |
| Coleoptera . | *Colpodes* sp. (? nov.). |
| | *Bidessus* sp. (? nov.). |
| | *Hyphydrus* sp. (? nov.). |
| | *Paederus* sp. (? nov.). |
| | *Leptocyrtinus* sp. (? nov.). |
| Hemiptera . | *Vitellus* sp. nov. |
| | *Limnogonus* sp. nov. |
| | *Luteva* sp. nov. |
| | *Enithares* sp. (? nov.). |
| | *Nesaphrestes* sp. (? nov.). |
| Orthoptera . | *Salomona magnifica*, Willemse. |
| | *Gryllacris poultoni*, Willemse. |
| | *Podoscirtus chopardi*, Willemse. |
| | *Megacrania bakeri*, Willemse. |
| | *Hemarchus uvarovi*, Willemse. |
| | *Hebridea rufo-tibialis*, Willemse. (*New genus.*) |
| Psocoptera . | *Liposcelis bakeri*, Pearman. |
| | *Nanopsocus oceanicus*, Pearman. (*New genus.*) |
| Collembola . | *Pseudosira flavescens*, Womersley. |
| | *Lepidocyrtus pseudopictus*, Womersley. |
| | *L. medioides*, Womersley. |
| Thysanura . | *Bakerella andersonae*, Womersley. (*New genus.*) |
| Gastropoda . | *Aneitea robsoni*, Hoffmann. |

## Appendix 5

## LIST OF THE NON-MARINE VERTEBRATE FAUNA OF THE NEW HEBRIDES

This list was prepared by the authorities of the British Museum of Natural History from three sources, namely: (1) specimens already in the Museum; (2) published records; and (3) the author's collections. The Fishes are simply those collected by the author. It appears that no freshwater Fishes (except one eel) had previously been collected in the New Hebrides.

### Mammals.

*Pteropus geddiei*, MacG.
*——— *eotinus*, K. And.
*——— *aneiteanus*, Gray.
*——— *bakeri*, Thos.
*Notopteris macdonaldi*, Gray.
*Hipposideros cervinus*, Gould.
*Miniopterus australis*, Tomes.
*Rattus exulans*, Peale.
Feral.
*Rattus rattus*, L.
*Sus papuensis*, Less & Garn.

### Birds.†

**Megapodius layardi*, Latham.
*Ptilinopus greyi*, Gray.
*———*tannensis*, Latham.
**Globicera pacifica farquhari*, Sharpe.
**Muskadivora bakeri*, Kinnear.
**Janthœnas vitiensis leopoldi*, Tristram.
**?Macropygia rufa rufa*, Ramsay.
**Chalcophaps chrysochlora sandwichensis*, Ramsay.

* Confined to the New Hebrides.
† Shore birds are excluded.

**Porphyrio calvus aneiteumensis*, Tristram.
*Porzana nigra vitiensis*, Hartlaub.
*Nyroca australis*, Eyton.
*Anas superciliosa*, Gmelin.
*Tyto alba lulu*, Peale.
*Trichoglossus hæmatodus massena*, Bonaparte.
**Hypocharmosyna palmarum*, Gmelin.
*Lamprococcyx plagosus layardi*, Mathews.
**Cacomantis prionurus schistaceigularis*, Sharpe.
**Halcyon juliæ*, Heine.
*—— *chloris tannensis*, Sharpe.
*—— —— *hyperpontia*, Oberh.
*——*farquhari*, Sharpe.
*Collocalia uropygialis uropygialis*, Gray.
——*fuciphaga vanikorensis*, Quoy & Gaimard.
*Hirundo tahitica*, Gmelin.
**Rhipidura brenchleyi brenchleyi*, Sharpe.
*—— —— *erromangæ*, Sharpe.
*—— *spilodera*, Gray.
*—— *verrauxi sancta*, Sharpe.
**Piezorynchus sericeus*, Ramsay.
**Petræca similis*, Gray.
*—— *ambrynensis*, Sharpe.
*Artamides caledonicus*, Gmelin.
**Lalage banksiana*, Gray.
*——*flavocincta*, Sharpe.
**Pachycephala chlorura*, Gray.
*—— *intacta*, Sharpe.
**Clytorhynchus pachycephaloides grisescens*, Sharpe.
*—— *vatensis*, Sharpe.
*Artamus melanoleucus*, Forster.
**Myzomela cardinalis cardinalis*, Gmelin.
*—— *splendida*, Layard & Tristram.
**Glyciphila notabilis*, Sharpe.
*——*flavotincta*, Gray.
**Zosterops flavifrons*, Gmelin.
—— *vatensis*, Tristram.

* Confined to the New Hebrides.

*—— *macgillivrayi*, Sharpe.
*Turdus mareensis*, Layard.
*—— *albifrons*, Ramsay.
—— *pritzbueri*, E. L. & L. C. Layard.
**Erythrura serena*, Sclater.
*—— *cyanovirens regia*, Sclater.
—— *cyanifrons*, E. Layard.
**Aplonis rufipennis*, Layard.

Reptiles.

*Gymnodactylus pelagicus* (Girard).
*Lepidodactylus lugubris* (Dum. & Bibr.).
*Peropus oceanicus* (Lesson).
—— *vorax* (Girard).
—— *mutilatus* (*Wiegm.*).
*Gecko vittatus*, var. *bivittatus* (Dum. & Bibr.).
**Lygosoma speiseri*, Roux.
—— *noctua* (Lesson).
—— *cyanogaster* (Lesson).
—— *samoense* (Duméril).
—— *cyanurnm* (Lesson).
—— *kordoanum* (Meyer).
—— *nigrum* (Hombr. & Jacq.).
*Cryptoblepharus boutoni*, var. *peronii*, Coct.
*Enygrus australis* (Montr.).
—— *bibroni*, Hombr. & Jacq.
*Crocodylus porosus*, Schneid (?).

Fishes.

*Anguilla megastoma*, Kaup.
—— *mauritiana*, Bennett.
—— *obscura*, Günth.
*Microdonophis polyophthalmus*, Blkr.
*Kuhlia rupestris*, Lacep.
—— *humilis*, De Vis.
—— *marginata*, Cuv. & Val.

* Confined to the New Hebrides.

*Therapon argenteus*, Cuv. & Val.
*Lutianus gembra*, Cuv. & Val.
*Ambassis urotœnia*, Bleek.
*Caranx hippos*, Linn.
*Gerres filamentosus*, Cuv. & Val.
*Scatophagus argus*, Linn.
*Lisa compressa*, Günth.
*Querimana crenilabis*, Forsk.
*Agonostomus plicitalis*, Cuv. & Val.
*Guavina gyrinoides*, Bleek.
*Ophiocara porocephala*, Cuv. & Val.
—— *aporos*, Bleek.
—— *macrolepidota*, Bloch.
*Gobius* sp.
*Awaous ocellaris*, Brouss.
—— *genivittatus*, Cuv. & Val.
*Sicyopterus tœniurus*, Günth.

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